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Mechanical Design of Robosot Port Dickson Polytechnic

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ABSTRACT: This paper is emphasize on the design and structure of an omni-directional mobile robot for the PPD Robosot . It includes the detail of a few aspects such as base platform design, types of wheels choosen, electrical and electronic system. The omni directional motion is prefered because its will ease the robot to perform in 4 sub categoriesof Robosot in Federation of International Robot soccer Association (FIRA) which are Localization challenge, Avoidance Challenge , Passing Challenge and Soccer.
KEYWORDS:FIRA, Omni wheels, Robosot.

I. INTRODUCTION

Robosot is one of the category in FIRA which is a medium for tertiary students to synthesis their multidiscipline knowledge and apply it to achieve the objectives of within its regulations. This challenging arena is opportunity forresearchers especially for young generation working with autonomous mobile robotic systems. This annually FIRA's event, which started in 1996, will catalyst interests in robotics in the young minds.

As a desired result of this events, the students and researcher will make the improvement in terms of all aspect in order to be the best in this arena.One of the important aspect is the mechanical design and base structure of the robot. There is various type of robotdesign can be use such as 2-wheels drive, 4-wheels drive and 3-wheels drive but must fulfil the requirement or competition rule.

II. DESIGN CONSIDERATION

There were factors to consider in designing the Omni-directional Robosot. The agility of the robot is important, and the weight must be suitable to avoid it been pushed by other teams on the field. In this game, purposely ramming another team's robot is against the rules, but some incidental contact would occur is allowed. The size of each robot shall be limited to a maximum of 45cm × 45cm (width × length). The height shall not exceed 70cm. The robot must be in a fully extended state when being measurement.

Platform

The overall design of the robot is shown in Figure 1. It has thereOmni-wheels to perform omnidirectional. The base platform material is 2mm thickness of Aluminium plate. The aluminium is chosen due to it is light in weight, easy to saw and easy bending to form the robot bracket. There 2-layer of platform which is the layer 1 at the bottom is to accommodate the space for the motor and motor driver

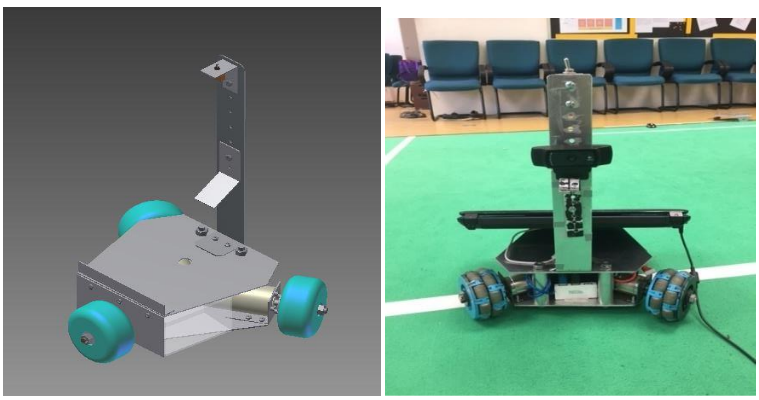

Fig. 1. Omni-directional Robot

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Mechanical Design

The robot has three Omni-wheels which are oriented at 120 degrees from each other. The reason for using three wheels instead of four is that it makes much easier for three-wheel robot to robustly contact with slightly irregular surface than four-wheel robot. It requires extra mechanical structure for four-wheel robot to robustly contact with the surface. The concept of designing is to fix all motors, drive units and wheels as compact as possible to fit in a limited robot size.

It is made for the FIRA Robosot game, so it requires high performance, but it must also robustly handle dynamically changing environment.To obtain the high performance, 24VOLT DC motors are used to drive the wheels so that the robot can move at a top speed of 3m/s.

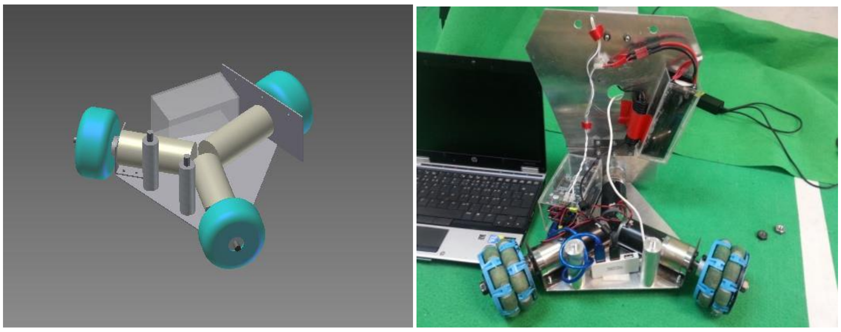

Fig. 2. Base 1 of the robot

Omni-Wheels

The wheels were arranged in 120° apart from each other in a symmetrical manner,this arrangement isused for selected motors would be able to move the vehicle at a sufficient velocity for the competition with minimum friction with field. The wheels in Figure 3 is produced by the Kornylak corporation and dubbed with the trans wheel, were designed for multipurpose in industry. They are sturdyand also economical. As can be seen from figure 3, the powered rotation along the primary diameter can be obtain, just as any other wheel. However, free rotation along an orthogonal direction to the powered rotation can be accomplished by the smaller rollers which is along the outside of this diameter.

Fig. 3. Trans wheel of the robosot

Electronics Design

The electronics control system design contains four blocks; camera driver, image processing (computer), arduino Mega main board and arduino motor driver shield.Thearduino mega 2560 main board is connected with arduino motor driver shield to be complex devices and the motion control unit. The computer image processing takes all outside data web-cam camera devices and then by using these data, it decides what to do next and send the action signal to the motor driver. The control unit is getting action signal from the process board and making the robot move by controlling three motors with omni-directional wheel motion. Computers are used to give the speed and directions signal. All programming are setting up with their parameters by using Roborealm(vision software) and arduino software. Figure 4 shows the complete electronics control system design on robot.

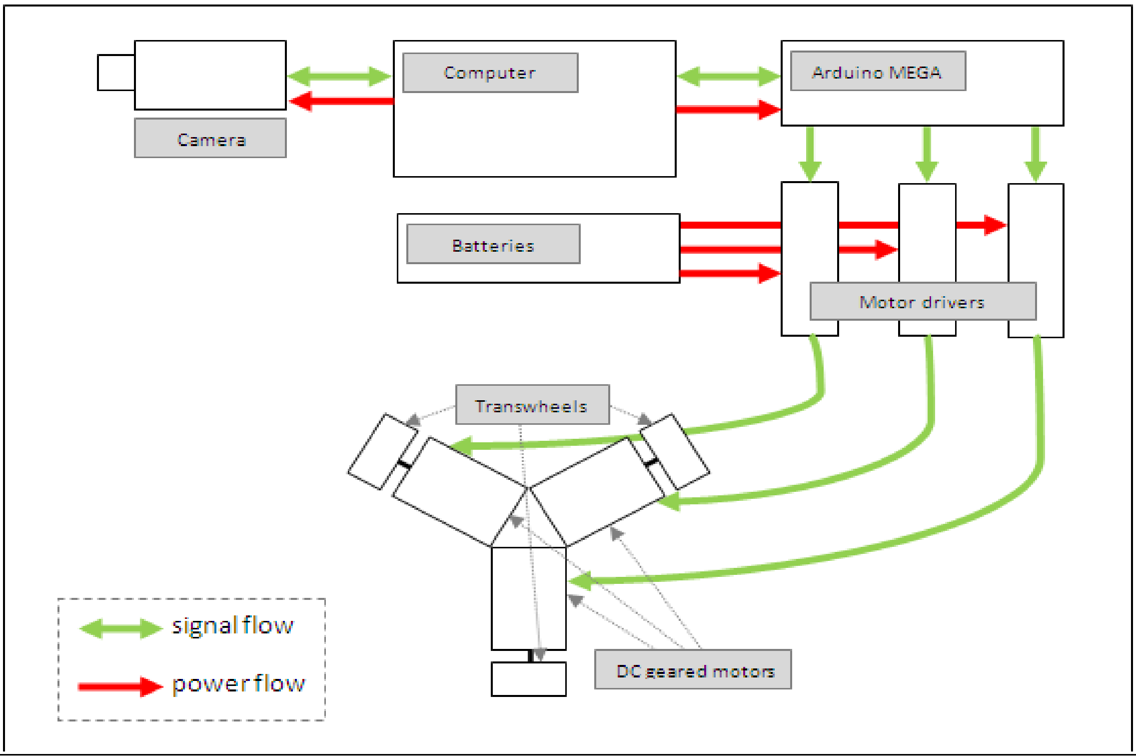

Fig. 4. Complete electronics control system design on robot.

Components of the Mobile Robot
Table (1) is the main components that havebeen used in the developmentof the robotsystem. The communication between microcontroller and image processing computer is done using serial USB cable.

Table 1,Robot Parts List

Quantity	Description
3	Motor shield/Motor Drive
1	Arduino Board (Arduino Mega 2650)
3	wheel (Transwheel)
3	Motor (24v DC planetary motor)
2	Body, Shaft, Plates (aluminium)
1	Battery (High Discharge Li-PO Battery)
1	Logitech Webcam (HD Pro Webcam C920/HD webcam C615)
1	USB Cable
1	Arduino Jumper Wire
3	Black Wire
3	Red Wire
1	Electronic Switch (on/off)

III. THREE-WHEELS DRIVE ASSEMBLY

In the left image, the parts in grey color represents the robotic platform, and the three motors coupled to transwheels are mounted with 120 degree between them. It is aligned like in an equilateral triangle so that their axis intersect at the robot centre.

PPDRobosot team prefered to use a three-wheel drive because it characteristic of manoeuvrabilityand also controllable. This type of wheelsable to move the robot freely on any direction. It is also easy to attach the motor shaft with this wheels by using its coupling. Even , only 2 motors are activated, The traction reduction is slightly compensated by the third wheel (not active) andtherefore the traction loss is partly compensated. The mechanical construction isshown in **Fig. 5**.

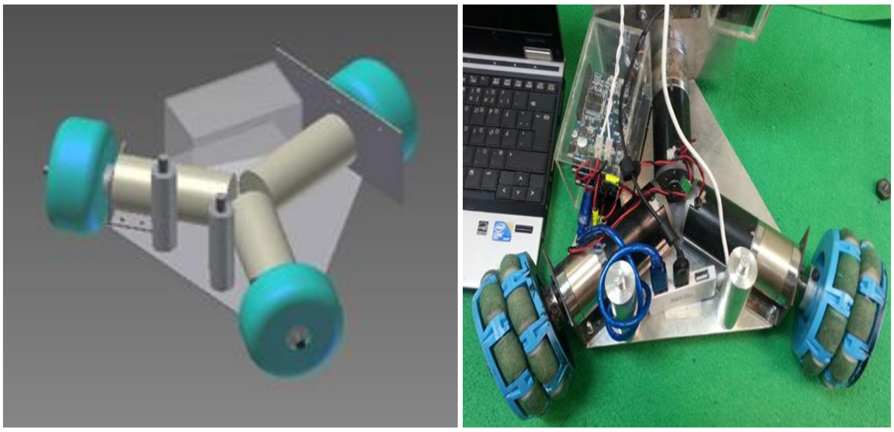

Fig. 5.Three-Wheel drive mechanical construction (design and physical)

Types of Motion

To perform a robot motion, there are fourdifferent cases which is forward, left, right, and circle movement. The direction of the robot depends on the active and not active wheel and its direction as shown in following **Table 2** and **Figs** (6,7,8 and 9). The sign + indicate the motor turn clockwise and sign – for anti clock wise whereas 0 for inative motor.

	Motor 1	Motor 2	Motor 3
Forward	+1	0	-1
Left	-1	-1	0
Right	0	+1	+1
Circle	+1	+1	+1

Table 2, Type Motion

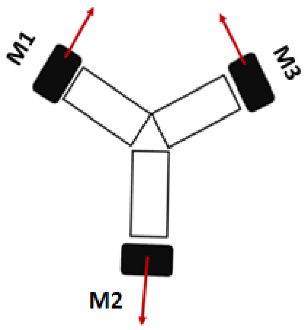

Fig. 6. Foward M1=+1, M2=0, M3=-1

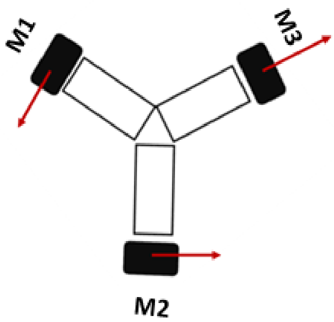

Fig. 7. Left M1=-1, M2=-1, M3=0

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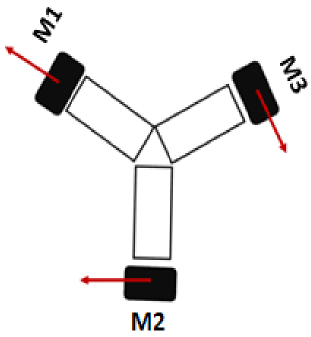

Fig. 8. Right M1=0, M2=+1, M3=+1

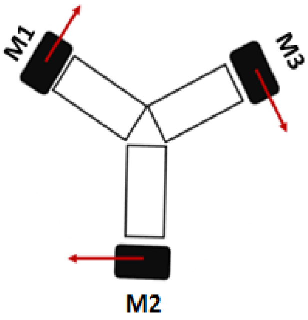

Fig. 9. Circle M1=+1, M2=+1, M3=+1

Motors

The motor chosen is IG45Planetary geared motor with 2.79 Nm at 49.5 Watts. This motor is chosen due to electricity consumption, speed, force, torque, and others.

Table 3 . Motor Characteristic

Characteristic	
Voltage	24 V (dc)
No load speed	185 rpm
Rated Speed	138 rpm
Gear Reducation	32.5
Torque	2.7916 Nm
Shaft Diameter	10mm
Current	4.4 Amp
Power Output	49.5 W

IV. CONCLUSIONS.

From the design and robot motion control the followingnotes can be concluded:

1. This Robosot design, is relatively fast, reaching the target both linear and angular speeds.
2. In FIRA Robosot, the speed a robot to reach the ball is extremelyimportance. The faster it gets to the target or to the ball the more chances it has to score a goal. With the 3 wheel drive configuration described in this paper a robot can move in a straight line all the time in any direction. It can move on opposite or reverse direction without turning to its direction first.
3. By using this design, it is an advantages and simplify the control software jobs.
4. The rotation of the system around its centre can be obtained by running the three wheels in the same direction.
5. A straight line motion can be achieved by running two wheels only in opposite direction.

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