International Journal of Technical Vocational and Engineering Technology [iJTvET]
e-SSN2710-7094, ISSN 2710-7086
Vol.3, No.1, 2022

STRATEGY FOR FIRA HUROCUP WEIGHTLIFTING TOURNAMENT: PUO ROBOT SOCCER TEAM

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Abstract

This paper presents the strategy of the Politeknik Ungku Omar (PUO) Robot Soccer Team in the FIRA HuroCup kid-size game for the weightlifting category. The problem with the weighting robot used by PUO is unable to maintain stability if the total number of disks is lifted more than 35 disks by using the original gripper hand. To increase the maximum disk, the new design gripper hand has been designed. The objective of this paper is to demonstrate the concept of static force based on two strategies that will be used for weightlifting events. For the first strategy, we demonstrated the differences in the total number of disks lifted by using an original gripper hand and a new design of the gripper hand. The second strategy is to develop a new lifting motion with the new design gripper hand as well as to break the previous disk lifting record. The RoboPlus software is used to design motion posture to bring the disk from the first line to the finish line. The results showed that by using the new design hand gripper 65 disks were successfully raised as compared to 35 disks by using the original gripper hand.
Keywords: Humanoid; Darwinn-OP; FIRA; Weightlifting

1. Introduction

Federation of International Robot-soccer Association (FIRA) was established in 1995 with the first FIRA tournament in 1996 held in Korean Advance Institute of Science and Technology (KAIST) for the Mirosot category(Suarez-Rivera et al., 2017). Now FIRA has seven categories including HuroCup, Mirosot, Androsot, Simurosot, Amiresot, Narosot and Robosot. FIRA Malaysia started in 2007 with the first tournament of FIRA Malaysia Cup held in Ungku Omar Polytechnic for only the Mirosot category. FIRA Malaysia has six categories including 5 original FIRA categories HuroCup, Androsot, Mirosot, Simurosot, Robotsot, and including one category for a secondary school in MyBot categories. The competition will be participated by various teams from Malaysian polytechnics, secondary schools, and also local universities. The competitions were organized to select the winner for each category that will be representing Malaysia to FIRA Roboworld and Congress. PUO humanoid team has participated in the tournament every year since 2012 including at national and international levels. In the year 2018, the PUO humanoid team has won the national HuroCup Category that was held in Politeknik Port Dickson ("Hurocup," n.d.) and will represent Malaysia at 23rd FIRA Roboworld and Congress in 2018 in Taichung, Taiwan ("2018 FIRA RoboWorld Cup," n.d.).

We use robot Darwin-OP that originally had no suitable shaped hand that will allow it to hold the rod lifter. At the previous FIRA Malaysia CUP, we used an original gripper for weightlifting events and manage to lift 32 disks but to lift more than 40 disks we face the problem of stability. Therefore, the design of a new shaped hand is needed that would allow the robot to lift more than 40 disks. For games weightlifting, robots are required to lift the disks using rods provided by each team according to the maximum allowed length of 40cm. Each team will be given three attempts and they can choose the number of discs on each trial. Based on the size of the Darwin robot for kid-size lifting more than 30 disks is a problem because the weight will be concentrated on the hand. If the position of the body shape is incorrect or unstable, the robot will easily fall forward due to the heavy burden concentrated on the hand.

2. Methodology

2.1 Hardware

In this Part, we described the hardware specifications for the Darwin-OP, the mechanical structure which was developed by the Robotis (Ha et al, 2013). The dimensions of Darwin-OP with coordinate systems are provided in Figure 1. The axes of rotations for the joints are shown as red arrows. These instructions have been based on the positive direction of rotation in hardware to facilitate the transformation of the model for implementation. The Darwin-OP front view is shown on the left, and side views are shown on the right of Figure 1. The detailed specifications are given in Table 1. Referring to Table 1, the Darwin-OP humanoid robots have been controlled by servo motor series with 20 degrees of freedom. All devices such as actuators, sensors, LEDs, buttons, and external I/Os are connected to the sub-controller by a serial bus network that fully supports DYNAMIXEL (S, 2018). Options with two single-DOF grippers may be installed, bringing the total up to 22 DOF. Each is controlled by a single Robotis MX-28T servo motor, accepting commands via a TTL connection at 1M baud. Each motor has a sensor to provide data of torque, speed, and position. The robot is additionally equipped with the subsequent sensors: FSR sensors in each foot, a three-axis gyro within the body part, a three-axis accelerometer within the body part, and a 320x240 resolution color digital camera within the head (Vasilyev et al,2019). The MX28T provides a range of motion of 360∘ and operates at 12V. The motors are directly controlled using a Robotis CM730 controller board, using stock firmware and the robot's main controller board is a FitPC2i, equipped with a single-core Intel Atom CPU running at 1.6GHz with 1GB of RAM. The CM730 is connected via a USB cable, as is the webcam (Li et al, 2016).

Figure 1: Darwin-OP with Coordinate Systems

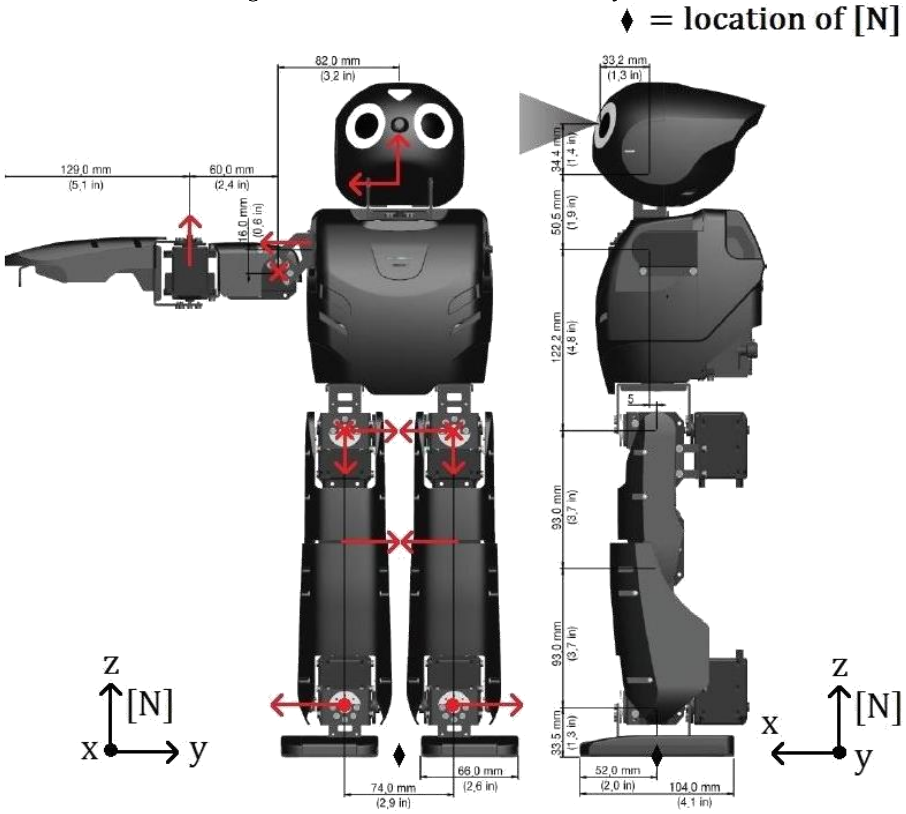


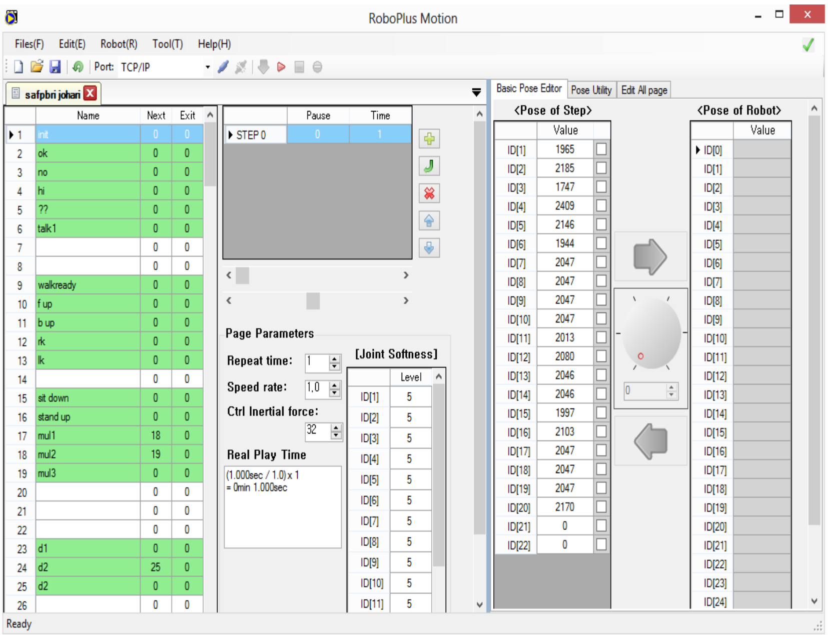
Table 1: Darwin-OP Hardware Specifications.

Darwin-OP		
Height (mm)	454.5	
Weight (kg)	2.9	
DOF	20	
Actuators	MX 28T	
Camera Type	2MP Logitech C905	
Sensors	Touch sensor and IMU	
Controller	Main Controller	Sub Controller
CPU	Intel Atom Z530 CPU (1.6GHz)	STMicroelectronics 32F103RE ARM Cortex 32-bit CPU (72MHz)
OS	Linux	None

2.2 Software

The robot was constructed using a hierarchical framework considering renovation and independence. This framework consists of communication device modules, motion modules, a running module, a sensing module, the module behavior, a vision module, and a diagnostic module (Cunha et al, 2016). This framework has been developed using the C ++ programming language in which this code is operating system independent.

Figure 2: Motion editor in RoboPlus



Without the need to develop a separate set of frameworks users only need to write a code of conduct for the Darwin-OP. The computer code machine is the most sensible technique of writing the program and testing the aforementioned program for Darwin-OP provided that such machine makes use of the provided framework. Darwin-OP is open-source and inspired by nature's users to share programs developed by different users. Users have not been limited to open-Darwin-only SDK even now independently developed software that does not perform open-SDK Darwin. There are examples wherever software package has been developed at "levels." for example low-level programming takes will watch out of the robot's sub-routines, like camera refresh times or browse the position of the actuator (Chiang et al, 2018). High-level programming can take care of those aspects that are more abstract than the robot and different levels of practical so recompiling the entire code is unnecessary in simple changes in behavior or subroutine parameters.

2.3 Method for creating motion

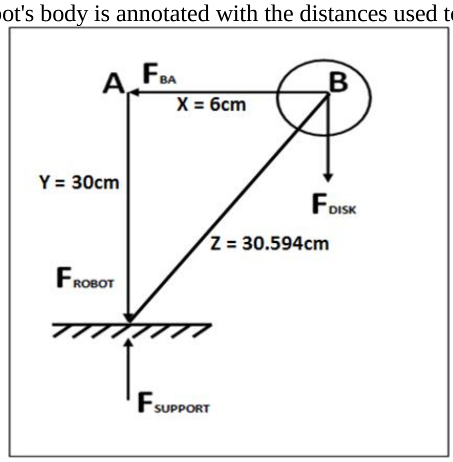
PUO humanoid robots are using RoboPlus software for creating motion, a program developed by ROBOTIS to customized programs for every product("ROBOTIS OP2," n.d.). Figure 2 shows RoboPlus in the development environment. RoboPlus software uses three methods to generate motion which are pose editing, step editing, and page editing. Robot position at some stage in the future and that a group of motor position needed to be called a robot posture poses in Roboplus. A "Pose Step" is referring to the values that give rise to actual data "Pose of Robot" refers to the values of the position of the robot joints connected. Once the "Pose of Robot" is modified value, the robot will move accordingly. While "Motion Step" means that by keyframes, that area unit needed to play consecutive motions, and therefore the speed of a motion is being decided by the time of every step. The step editor enables steps to be simply adding the speed of a motion is set by the time of every step and also the step editor edited steps to be edited simply. Each page consists of a maximum of seven steps and to move more than seven steps, there will be a need to connect the page. A "Motion page" is that the unit used to distinguish between saved motions and imported motions is read in terms of pages and motion data consists of 255 pages. Some controllers are restricted to solely 127 pages.

2.4 New Hand Design

Any movements made by the robot places a burden on the motor and it is difficult to balance without falling with the weight concentrated in the hands. Before this, we used the gripper 4DOF produced by Robotis. The gripper cannot be carrying more disks due to its weight and making a long arm. To solve this problem, a new hand was developed to replace the gripper with a more appropriate hand. A robot in a static state will not fall forward when it is in stable condition with the weight of the robot and disks. Unbalanced will occur when the robot is placed in tension or compression, and in this case, a disk becomes a burden to it. Figure 3 shows the side views of the robot when using the new design with the reducing the value of X. Figure 4 is the robot's body annotated with the distances used to calculate forces. The values for x, y, and z are the distance of the robot position while performing forces at critical levels. By using the triangle labeled as X position, Y position, and the position Z. The values for positions X, Y, and Z are the distance of the robot position while performing forces at critical levels.

Figure 3: The side view of Robot when using the new design.

Figure 4: The robot's body is annotated with the distances used to calculate forces.



Based on Newton's first law, this situation implies that the net force and net torque (also known as moment of force) on every part of the system are zero (Journal et al., 1924). The balance can be maintained by using the static formula. By reducing the distance of X or Y, stability can be added. In this case, the value of Y is retained when the value of X is reduced so that the robot will be more stable and thus can lift more disks.

$$\sum F = 0 \quad (1)$$

$$F_{ROBOT} + F_{DISK} = F_{SUPPORT} \qquad (2)$$

Indeed, this technique uses a static equation and requires certain assumptions about the real world:

i. This robot is standing. (Velocity is zero).
ii. The surface beneath the robot is flat.
iii. This robot is on the surface (not floating in the air).

3. Results and Discussion

The main goal of this paper is to demonstrate the effect of static force and replace the hand gripper used with a new design to prove it can lift more disks than the previous gripper with the same posture by using RoboPlus software. Therefore, many tests have been conducted with the increasing number of disks. Our results in experimental lifting disks are summarized in Table 2. Based on the results of the experiment conducted, has successfully risen to 60 disks compared to the gripper used previously with 35 disks. Records made by the PUO humanoid team of 55 disks were achieved in the 14th FIRA tournament held in Port Dickson ("Hurocup," n.d.).

Table 2: Results in the experiment

Number of disks	New design	Original gripper
10	Success	Success
15	Success	Success
20	Success	Success
25	Success	Success
30	Success	Success
35	Success	Success
40	Success	Fail
45	Success	Fail
50	Success	Fail
55	Success	Fail
60	Success	Fail
65	Fail	Fail

4. Conclusion

This study describes the new gripper used by the PUO humanoid team to break the national record in the weightlifting category humanoid kid sizes. For the upcoming tournament, the PUO humanoid team hopes to maintain its winning in this event and subsequently apply its use in other events. There is a Hope that the modified robots will be placed highly in national competitions, including the Malaysia Cup and international competitions.

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