Alexandia University

Faculty Of Engineering

MIA Electrical Team

Motor Selection

Prebared by:

Group 6

Contents

TASK12.2- ROBOCON

About

- ABU Robocon is an international robot contest organized annually by the Asia Pacific Broadcasting Union (ABU). It's a platform that challenges young engineers to design and build robots for specific tasks, often inspired by popular games or sports. The competition aims to promote creativity, engineering skills, and teamwork among participants.

- Robocon 25 will be the 24th edition of the competition, held in Ulaanbaatar,Mongolia. The theme for this year is "Team Effort, Ultimate Success," and the challenge will be a basketball-themed game.

- Teams had to build two robots to work together, simulating a basketball match. The robots were required to:
  - Dribbble the ball.
  - Pass the ball to teammates.
  - Shoot the ball into the hoop.

Requirement

- **Movement Motors:** Choose the appropriate motors to power the robots' overall movement and locomotion.
- **Dribbling Motors:** Select motors specifically designed for the task of dribbling a ball, considering factors like torque, speed, and control.
- **Shooting and Passing Motors:** Determine the necessary motors for both shooting and passing the ball. Specify if different types of motors are required for these actions, such as those with varying torque or speed characteristics.
- Include links to the selected motors if suitable options are found (they do not need to be available in the local market).

ROBOCON rules

➢ Most relevant rules

- playground area: 15 x 8 (meters)
- basket height: 2.43 meters
- A robot can be controlled manually, semi automatically, or automatically
- both dropping and picking up the ball must be performed from a height of at least 70 cm above the ground surface measured from the lowermost of the ball
- valid pass range: must be at a distance of at least 1 meter
- ball diameter: 75 cm
- ball weight: 580-620 grams * max source voltage = 24V
- Power circuits of Robots should be designed so that any actual voltages in the circuits should be 42V or less.
- the total weight of both robots, including batteries, controllers, cables, spare mechanisms, the foam rubber protective bars and equipment, must not exceed 50kg. let's say that the weight of each robot will not exceed 20 kg.

➢ less relevant rules

- communication allowed: WI-FI(IEEE 802.11), Zigbee(IEEE 802.15), and bluetooth
- robot must fit within a cylinder with dimensions of 80 cm (diameter) x 150 cm (height) before a game starts.

Motor selection

➢ Movement Motors

For movement we chose a brushless DC motor for its high speed and longivity

In order to calculate the appropriate specs of the movement motors, we made some assumptions:

- Robot's wheel radius = 50 cm
- Robot's max speed = 4.5 m/s
- RPM according to the previous parameters = 86 RPM
- Acceleration = $4m/sec^2$

Each wheel has its own motor both robots are identical, each of them has a mass of 20 KG.

➔motors power = mass * acceleration * linear velocity

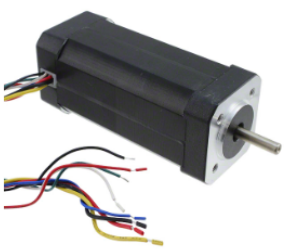


Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

QBL4208-100-04-025

DigiKey Part Number	505-QBL4208-100-04-025-ND
Manufacturer	Analog Devices Inc./Maxim Integrated
Manufacturer Product Number	QBL4208-100-04-025
Description	STANDARD MOTOR 4000 RPM 24V
Manufacturer Standard Lead Time	18 Weeks
Customer Reference	
Detailed Description	Brushless (BLDC) DC Motor Standard 4000 RPM 104.7W 24VDC
Datasheet	Datasheet

According to all of the above, the motor's power should be at least equal to 90 watts.

So we choose this motor after filtering the inappropriate ones

Type	DC Motor
Function	Standard
Motor Type	Brushless (BLDC)
Voltage - Rated	24VDC
RPM	4000 RPM
Torque - Rated (oz-in / mNm)	35.4 / 250
Power - Rated	104.7W

And this is the link of the motor for more details

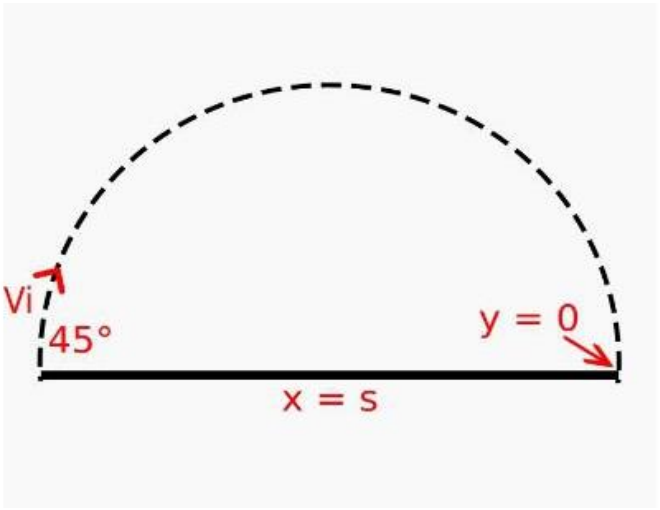
https://www.digikey.com/en/products/detail/analog-devices-inc-maxim-integrated/QBL4208-100-04-025/4843440

➢ Shooting and Pass Motors

for shooting and passing motors, we are going to use a servo for its dynamic responses and high torque to weight ratio.

- **pass motor calculations**

  first, we calculate the initial velocity which robot needs to pass the ball



S= $\boldsymbol{V_i . t . cos(45)}$ **→ (1)**

y=$V_i . t . \sin(45) - \frac{1}{2} * 9.81 * t^2$ at y=0

$V_i * t * \sin(45) = \frac{1}{2} * 9.81 * t^2$

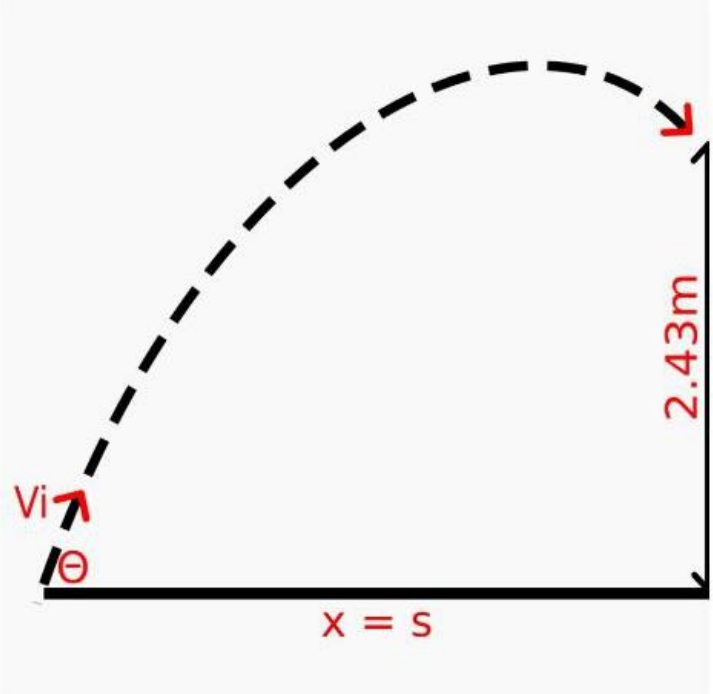
$\boldsymbol{V_i sin(45) = 0.5 * 9.81 * t \rightarrow (2)}$

$4.905 * \frac{S}{V_i * \cos(45)} = V_i * \sin(45)$

$\boldsymbol{4.905S = 0.5 * V_i^2}$

At S=1m → Vi=3.132 m/sec (least allowed distance)
At S=10m → Vi=9.905 m/sec (max assumed distance)

- **Shooting motor calculations**



To determine the initial velocity the robot need to shoot
We can assume that theta = 70 and x = 1
If X=S= 1 = Vi*cos (70)*t → 1
Y= 2.43 = $\boldsymbol{V_i}$*t*sin(70) – 0.5*9.81*t^2 → 2

$2.43 = V_i \left(\frac{1}{\cos(70)}\right) * \left(\frac{\sin(70)}{\boldsymbol{V_i}}\right) - 0.5 * 9.81 * \left(\frac{S}{V_i * \cos(70)}\right)^2$

Vi = 11.5 m/sec

➔So, shooting needs a slightly stronger throw than passing, so we need to find the specs we need in order to shoot and pass the ball

➔We assumed that the robot will have an arm that is 0.3 meters long divided into two sections divided by a joint, the first section *sectionA* is responsible for aiming at the appropriate angle, it is 0.1 meters long. The second section *sectionB* will be responsible for the action of dribbling, throwing and shooting the ball.
➔We assumed that section will have 120 degrees of freedom to move and gain speed

- **Calculating the appropriate specs of sectionB motor:**

$\Theta = 120° = \frac{2\pi}{3}\ rad$
The length of the arc = Θ * r = ($\frac{2\pi}{3}$) * 0.2 = 0.418879m
$V_f^2 = V_i^2 + 2aS$
Vi=0 , S= 0.418879 Vf= 11.5m/sec
a = 157.86m/sec^2
F= m*a = (620*10^{-3}) * 157.86 = 48.9366N
Torque = F*r = 48.9366 * 0.2 = 9.787 N.m
Vf= Vi + at t=0.0728sec
P= $\frac{F.S}{t}$ = 281.57W

After filtering we chose the appropriate one for this task

SBL80D3-03

Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

DigiKey Part Number	2090-SBL80D3-03-ND
Manufacturer	Lin Engineering
Manufacturer Product Number	SBL80D3-03
Description	750 WATT BLDC SERVO MOTOR - 80 M
Manufacturer Standard Lead Time	16 Weeks
Customer Reference	
Detailed Description	Brushless (BLDC) DC Motor Servomotor 3000 RPM 750W Incremental 48VDC
Datasheet	Datasheet

Type	DC Motor
Function	Servomotor
Motor Type	Brushless (BLDC)
Voltage - Rated	48VDC
RPM	3000 RPM
Torque - Rated (oz-in / mNm)	339.8 / 2400
Power - Rated	750W

For more details here is the link

https://www.digikey.com/en/products/detail/lin-engineering/SBL80D3-03/18342889

- **Dripping Motor**
  We will use the same servo motor we choose in pass and shoot task as this motor is very accurate and has the appropriate force to drip a ball
- **sectionA motor:**
  for section A, we need the arm to be precise and steady in order to hold position while sectionB is moving aggressively, so we chose this stepper motor:
  SS2421-50XE100 Sanyo | Motors, Actuators, Solenoids and Drivers | DigiKey Marketplace