Robotics II Laboratory

Report on Task 01

Locomotion and Propulsion

SS 2020

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TABLE:

FIGURE:

1. *For each robot, identify its class/type, locomotion mechanism involved, corresponding resistance force to this kind of motion and suitable environment(s) for such a mechanism. Tabulate your results as shown in Table 1.*

Robot	**Characteristics**	
Robot_01	Type/Class:	Wheel robot
	Locomotion mechanism:	Rolling
	Resistance force:	Friction
	Environment(s)/Terrain:	Flat surfaces
Robot_02	Type/Class:	Legged robot
	Locomotion mechanism:	Bipedal walking (2-Legged locomotion)
	Resistance force:	Gravitation forces
	Environment(s)/Terrain:	Flat surfaces and is restricted on bumpy surfaces.
Robot_03	Type/Class:	Wheel robot
	Locomotion mechanism:	Rolling
	Resistance force:	Friction
	Environment(s)/Terrain:	All surfaces (but not too steep)
Robot_04	Type/Class:	Wheel robot
	Locomotion mechanism:	Rolling
	Resistance force:	Friction
	Environment(s)/Terrain:	Best suitable for flat surfaces (manual operated)
Robot_05	Type/Class:	Aerial robot
	Locomotion mechanism:	Flight (rotor type)
	Resistance force:	Air resistance, gravitation, torque
	Environment(s)/Terrain:	Aerial (no obstacle detection)
Robot_06	Type/Class:	Legged robot
	Locomotion mechanism:	Walking (6-Legged locomotion)
	Resistance force:	Gravitation forces, loss of kinetic energy
	Environment(s)/Terrain:	Suitable in cumbersome areas as well
Robot_07	Type/Class:	Omni-wheel robot
	Locomotion mechanism:	Rolling (wheeled locomotion)
	Resistance force:	Friction
	Environment(s)/Terrain:	Best suitable for flat surfaces
Robot_08	Type/Class:	Snake-like amphibious robot
	Locomotion mechanism:	Rolling (wheeled locomotion)
	Resistance force:	Friction
	Environment(s)/Terrain:	Suitable for flat and bumpy surfaces
Robot_09	Type/Class:	Wheel robot
	Locomotion mechanism:	Rolling (wheeled locomotion)
	Resistance force:	Friction
	Environment(s)/Terrain:	All surfaces
Robot_10	Type/Class:	Track robot

	Locomotion mechanism:	Tracked slip/skid Locomotion
	Resistance force:	Friction
	Environment(s)/Terrain:	Even on rougher terrain

Table. 1: Robot characteristics

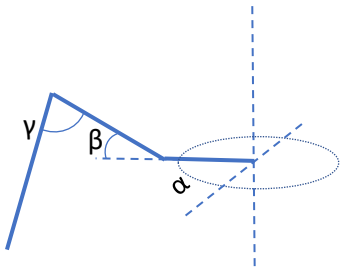
2. *For all wheeled robots, identify the type of wheels, identify the number and describe the degrees of freedom for a single wheel. Tabulate your results as shown in Table 2.*

Robot Class	**Wheel Type**	**Number of DoF**	**Description of DoF**
Ball Robot (Robot_01)	Ball or Spherical Wheel	3	Ball or spherical wheel rotates freely in all 3 directions.
Pioneer (Robot_03)	2 Standard and 1 Castor wheels (support)	2	Rotation around the (motorized) wheel axle and the contact point.
Youbot (Robot_04)	Swedish Wheels	3	Rotation around the (motorized) wheel axle, around the rollers and around the contact point.
Omni Platform (Robot_07)	Type of Mecanum Wheel	3	Rotation of disc and bottom wheel rolls around wheel axle and also at the point of contact.
ACMR (Robot_08)	Standard	2	Rotation around the (motorized) wheel axle and the contact point.
Robotnik Summit (Robot_09)	Swedish Wheels	3	Rotation around the (motorized) wheel axle, around the rollers and around the contact point.

Table. 2: Robot wheel types and Degrees of Freedom

3. *For Robot 06, identify the degrees of freedom of one of the legs and name the corresponding angles for each degree of freedom (provide a sketch if necessary)*

Degrees of freedom: 03



α - Joint angle between Body and Coxa

β - Joint angle between Coxa and Femur

γ - Joint angle between Femur and Tibia

Fig. 1: Degrees of Freedom for Robot_06 with corresponding angles.

4. *Comment on the stability requirements for Robot 01 versus Robot 06.*

The stability of a robot depends upon the following factors:

a. Number of contact points
b. Center of gravity
c. Static/dynamic stabilization
d. Inclination of terrain

Considering a flat terrain for both robots,

Robot_01:

- There is only 1 point of contact with the ground and so it is not statically stable without any support.
- The robot is dynamically stable if the centre of gravity of the body lies within the triangle formed by the three wheels (that are in contact with the spherical wheel).

Robot_06:

- For legged Robots, 3 legs are required for static stability but 6 legs are required for the static walking stability.
- Hexapod is a six-legged robot and it has static walking stability and it possesses dynamic stability.

5. *Describe how Robot_04 and Robot_07 achieve:*

    a. Forward and backward motion

    b. Left and right motion

    c. Clockwise and counter clockwise turning

Motion	**Robot_04**	**Robot_07**
Forward motion	All wheels rotate synchronously forward.	Right side (front and rear) wheels rotate clockwise and left side (front and rear) wheels rotate counter clockwise.
Backward motion	All wheels rotate synchronously backward.	Right side (front and rear) wheels rotate counter clockwise and left side (front and rear) wheels rotate clockwise.
Right motion	Front right and Rear left wheel rotate backward. Front left and Rear right wheel rotate forward. (Diagonally opposite wheels rotate synchronously)	Rear (right and left) wheels rotate clockwise and Front (right and left) wheels rotate counter clockwise.
Left motion	Front right and Rear left wheel rotate forward. Front left and Rear right wheel rotate backward. (Diagonally opposite wheels rotate synchronously)	Rear (right and left) wheels rotate counter clockwise and Front (right and left) wheels rotate clockwise.
Clockwise rotation	Right side (front and rear) wheels rotate backward. Left side (front and rear) wheels rotate forward. (one sided wheels rotate synchronously)	All wheels rotate synchronously counter clockwise.
Counter clockwise rotation	Right side (front and rear) wheels rotate forward. Left side (front and rear) wheels rotate backward. (one sided wheels rotate synchronously)	All wheels rotate synchronously clockwise.

Table. 3: Motion techniques of Robot_04 and Robot_07

6. *Introduce each of the ten robots (one at a time) into the environments in "Terrain-1", "Terrain-2" and "Terrain-3", simulate and record 30 seconds of video for each robot performing in the three environments.*

    Please refer to the video attachments sent along with this report.

7. *Comment on the suitability of each robot in the terrains. Again, tabulate your results.*

    a. Terrain-1
    b. Terrain-2
    c. Terrain-3

Robot	**Terrain**	**Suitability**
Robot_01	Terrain_01	It is suitable because the Terrain 01 is flat and there is no obstruction for the rolling movement for the ball robot.
	Terrain_02	The chances for the robot losing its stability is higher than the Terrain 01 because the surface of the Terrain 02 is bumpy.
	Terrain_03	The Terrain 03 has a steep and uneven surface so the stability of the ball robot is very less compared to the other two terrains.
Robot_02	Terrain_01	Terrain 01 is suitable for the humanoid robot as long as the step size and the walking speed is not large.
	Terrain_02	The humanoid robot has to estimate the position where it lands its feet which is difficult on terrains with bumpy surfaces.
	Terrain_03	The humanoid robot is not suitable for the steep terrains because it is difficult for the movement. For this to happen sophisticated algorithms are required.
Robot_03	Terrain_01	Pioneer robot is suitable for flat surfaces.
	Terrain_02	It is also suitable for rough terrains because center of gravity is low and makes this to have a good contact with the surface.
	Terrain_03	This terrain is steep. So, there are peaks and valleys which makes this robot difficult to move in this terrain.
Robot_04	Terrain_01	This robot has four wheels which makes the robot suitable for flat surfaces. Point of contacts are more. So, it can stay stable.
	Terrain_02	On this surface Youbot can move without any difficulty. The robustness is high in this Robot which makes it suitable.
	Terrain_03	This surface is not suitable to move the robot because it gets stuck and which makes this movement restricted.
Robot_05	Terrain_01	Quadcopter is an aerial robot, so it can work on any surface as long as there are no obstacles in its path.
	Terrain_02	
	Terrain_03	

Robot_06	Terrain_01	Hexapod can move on flat surfaces because it possesses static walking stability as it has six legs.
	Terrain_02	Hexapod can move on bumpy terrains but there is a high probability for the robot to get stuck. So, it is better to avoid on these surfaces
	Terrain_03	This surface is not suitable for hexapod robot because of the same reason as that of terrain 02.
Robot_07	Terrain_01	Omni-platform robot will be best suitable for flat surfaces.
	Terrain_02	This type of robot is not preferable on bumpy terrains as there is a possibility for the restriction of wheel movement.
	Terrain_03	Omni-platform robot is also not suitable for the steep surfaces because it has peaks and valleys which makes the wheels to get constrained.
Robot_08	Terrain_01	As ACMR robot is flexible it can move on flat surfaces with ease.
	Terrain_02	On this terrain this robot faces difficulty to overcome the obstacles. So, the motion is constricted.
	Terrain_03	Due to more obstacles on this terrain it has more constrained motion comparing with other terrains.
Robot_09	Terrain_01	Robotnik Summit can move on flat surfaces without any restriction.
	Terrain_02	It is also suitable for rough surfaces because of the type of grooves used on the wheels.
	Terrain_03	This robot can move on these surfaces with good ease because of the softer rubber compound on tires.
Robot_10	Terrain_01	Edgeless robot is very robust and because of its continuous track tires it can move on any kind of terrain.
	Terrain_02	
	Terrain_03	

Table. 4: Terrain suitability