

**Daffodil International University**  
**Fall 2020**

**Teacher Initial:**  
**IJN**

**Department of Computer Science and Engineering**  
**Final Open Book Examination Answer Script**

**Full Marks: 40 Allowed, Time: 4hrs (from: 09:00 to: 01:00 )**

**Date: Thursday 24, December 2020**

**Submission Date: Thursday 24 December, 2020 by 01:00pm**

**General Information (must be filled by the student)**

**COURSE CODE:**

CSE444

**SECTION:**

09

**PROGRAM:** DAY

**STUDENT ID:**

171-15-8782

**TIME STARTED:**

09:00 AM

**TIME ENDED:**

01:00 pm

**[Student must HAND WRITTEN the answers in this template; In case needed just write your detail on the paper using hand]**

**\*\* Plagiarism will be checked while you submit your response. You are advised to be honest during the open book exam.**

Ans. to the Q. No-1

Motor is an important and essential part for robot ~~for~~ preparing. There are several types of motors:

- i) Dc motors
- ii) Stepper motor
- iii) Servo motor

① Dc - motor:

There are some advantages and disadvantages of Dc motors:

Advantages:

- i) This motor's starting torque of Dc series is comparatively higher than any other motors.
- ii) For this motor we can use series wound motors so its also known as universal motors.

- (ii) Compare with shunt motor DC series motor develop more power for the same construction size.

### Disadvantages:

- ① Speed control and regulation of DC series motor are not good as other.
- ② And it is necessary to have a load before starting the DC series motors. So, DC series motors are not good to use where load does not apply to the initial stage.

### ② Stepper motors:

When incremental rotary motion is required in a robot, it is possible to use stepper motors.

So, there are some advantages and disadvantages of stepper motors.

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Advantages:

- ① This is the low cost for control achieved than any others.
- ② And also ruggedness
- ③ simplicity of construction
- ④ It can operate high load
- ⑤ ~~low~~ Need low maintenance
- ⑥ It is less likely to stall or slip
- ⑦ It will work in any environment

Disadvantages:

- ① It requires a dedicated control circuit
- ② Use more current than D.C motors
- ③ High torque output achieved at low speeds.

### ③ Servo Motors:

There are some advantages and disadvantages of servo motors:

#### Advantages:

- ① power supply available everywhere.
- ② low cost than others.
- ③ large variety of products.
- ④ high power conversion efficiency.
- ⑤ Easy maintenance.
- ⑥ No pollution in working environment.

#### Disadvantages:

- ① overheating in static conditions.
- ② need special protection in flammable environments.
- ③ Some advanced models require more complex control laws.

In my opinion the servo motors will be the best option for Robot building.

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Ans. to the Q. NO-2(a)

According to the scenario we can see that my mother needs a robot to that can help her and the robot name is Helper-123. It has some ability to avoid obstacles, follow lines, recognize gestures of my mother and sense the touch of my mother and the robot can recognize my mother touch and make my house clean. The whole process would work with some sensors and actuators.

We can use the proximity and distance sensor and the servo motor as a ~~into~~ actuator.

Proximity sensor: There have some kind of proximity sensor

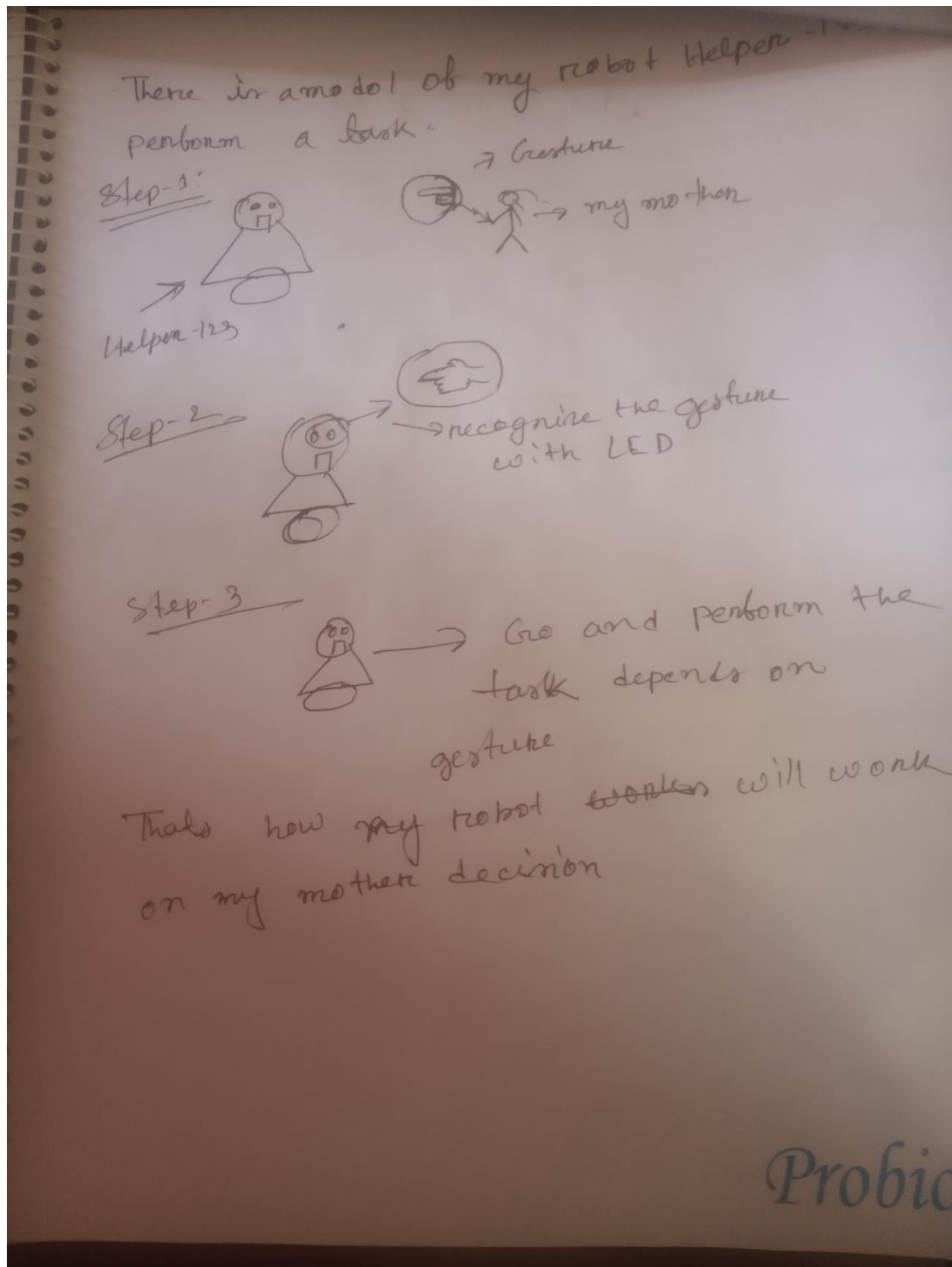
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- i) Structure light
- ii) Infrared light
- iii) Ultrasonic

First two sensors work with LED. The LED can detect the front obstacle and can run the specific task for that. and Ultrasonic is a use of sound wave propagation and reflection, works with <sup>in</sup> voice recognition.

Actuator: The servo motor actuator is most usable actuator used in robot. Because to do any task, the robot needs to move and it should do any task. So it needs a servo motor to perform the movement of body.





Ans. to the Q. No-2(C)

According to the scenario I want to make a robot for covid-19 affected people.

The robot's name is Corona-Bot 20. This will collect heart rate or pulse, oxygen level in blood, temperature of patient's body and send them to cloud server.

In my opinion the digital type data will get from patient's body and it will be the digital data.

Accuracy: Accuracy is kind of agreement where given some measured value with a given reference ~~stand~~ standard.

Repeatability:

Precision: If the output of the value is different that precision

is low. Because precision is depend on the robot result.

Resolution: The resolution is the smallest increment of measure that a device can make. It means every time you measure the temperature and everytime the increment the value of output.

Ans. to the Q. NO-3

Message communication: The message communication is the most fundamental technical point of Robot operating system depends on nodes.

The nodes are given below:-

(i) Run master: XMLRPC: Remote Procedure call in ROS the command will be `$roscore`

Master

XMLRPC: server

Administering Node information

(ii) Run subscriber node: The `packagename` `nodename` command `$roscrun`.

Master

XMLRPC: server

Administering Node information

Subscription Node info

name, topic name  
message type  
host

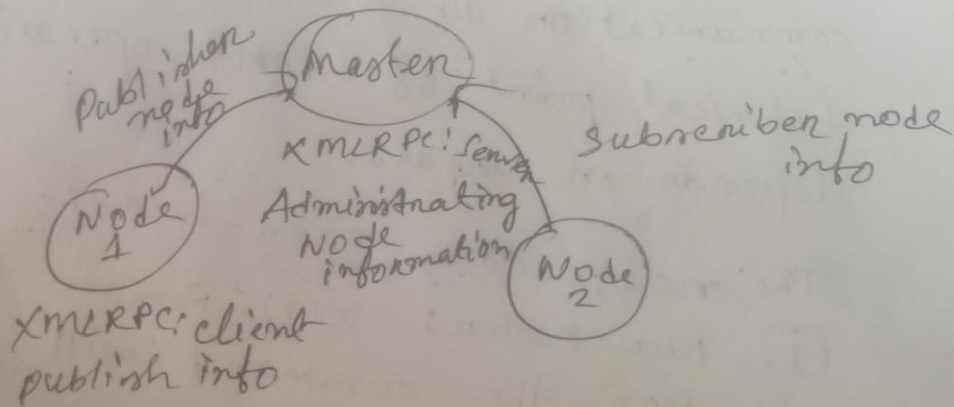
Node 2

XMLRPC: client  
Subscribe  
Subscribe information  
Subscribe

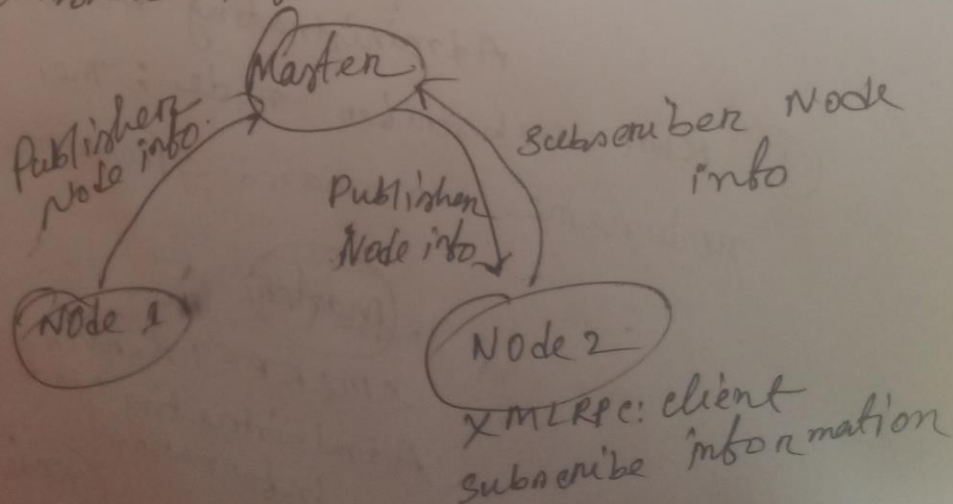
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### ③ Run publisher node:

The package name no name -  $\$ rosrun$

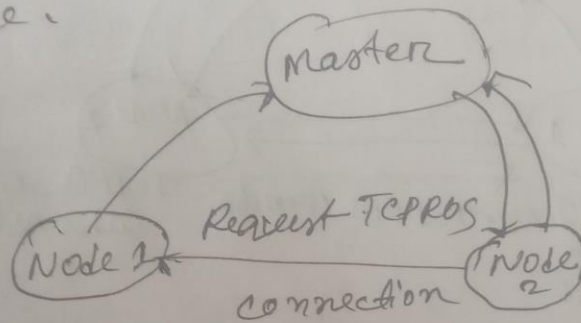


### ④ Publish Information: The master informs the subscriber node of the new publisher information

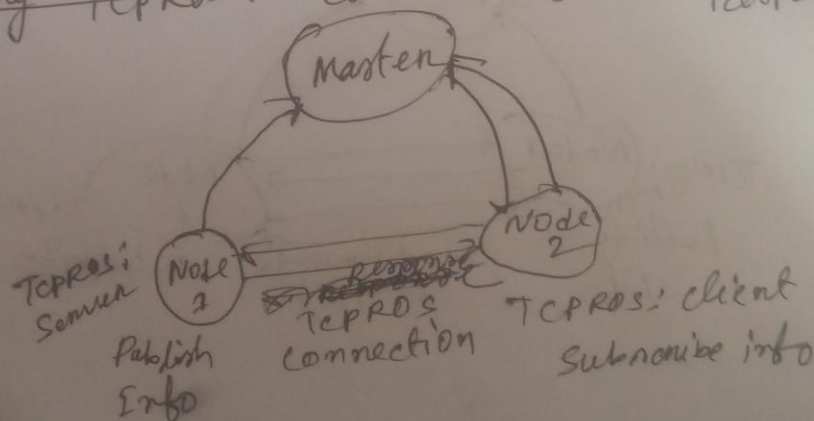




5. Request access to the publisher node:  
That request TCPROS connection using the publisher information from the master node.

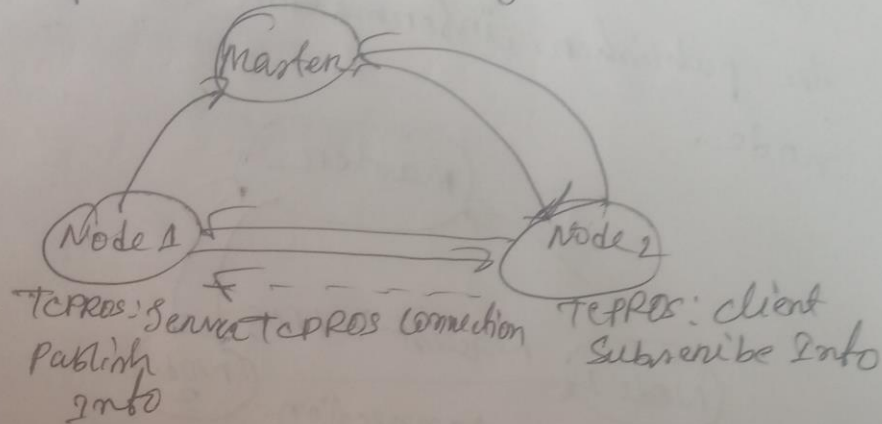


6. connection response to subscriber node:  
Establish connection with the publisher node using TCPROS. Return TCPURL and port numbers corresponding to the connection response.

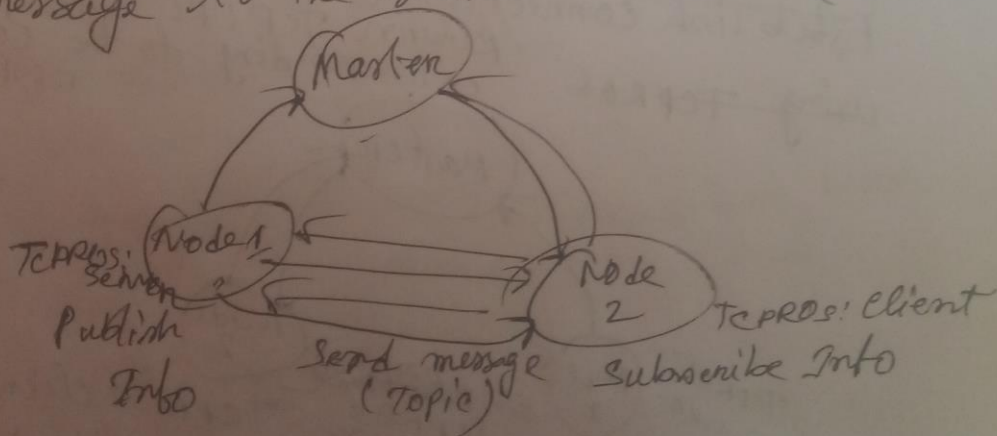


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7. Tcp connection: Establish connection with the publisher node using TCPROS

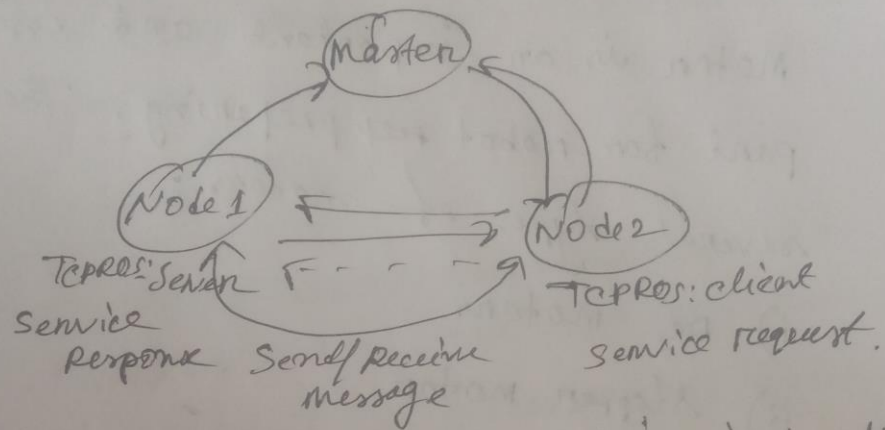


8. Send message: The publisher node sends a message to the subscriber node (Topic)





9) Service Request and Response:



The best example of this is turtlesim package which directed by keyboarded node.

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Ans. to the Q. No-4(a)

According to the scenario I want to make a robot that ~~can~~ named ABC. It can move Forward, Backward, Left and Right with the instruction given via bluetooth from my smartphone. The robot has a light that can move a light in every direction that set on the top of it. The robot with light band.

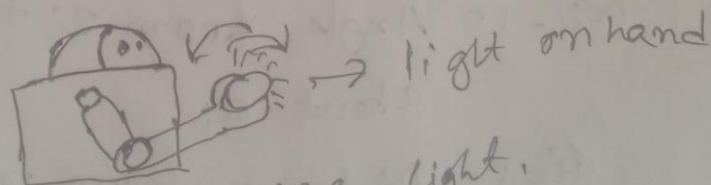


Fig: ABC light.

DH notation of light

There is some link and joint parameters.  
 $a_{i-1}$ : Link length (mutual perpendicular distance between z axis)

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$\alpha_{i-1}$  = Link Twist = Angle from axis  $\hat{z}_{i-1}$  to  $\hat{z}_i$

$d_i$  = Link offset = The offset distance between  $\hat{z}_{i-1}$  to the next

$\theta_i$  = joint angle = Rotation of link with respect to its neighbor.

$a_{i-1}$  = Distance from  $\hat{z}_i$  to  $\hat{z}_{i+1}$  measured along  $\hat{x}_i$

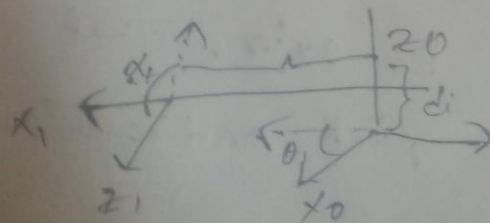
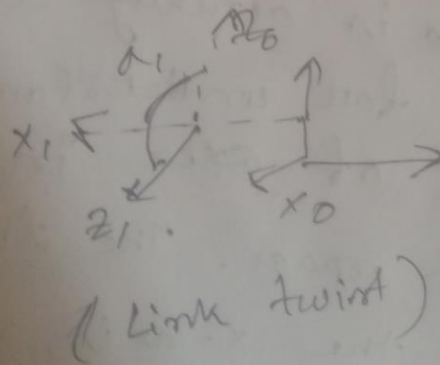
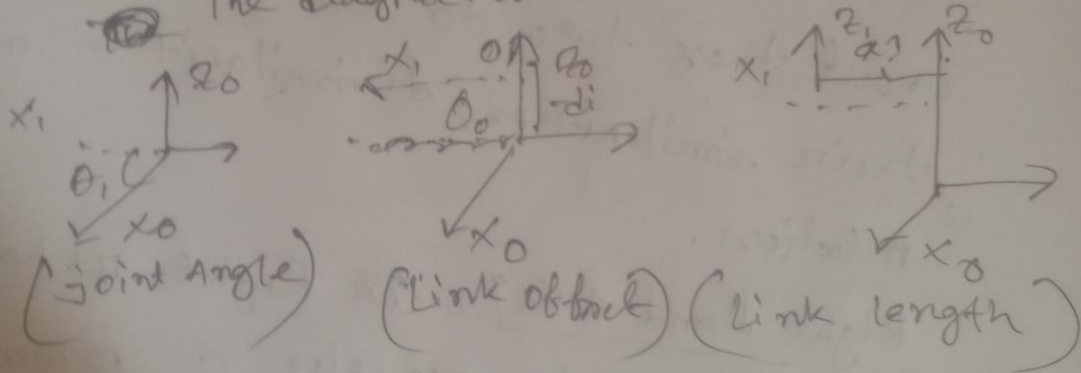
$\alpha_i$  = Angle from  $\hat{z}_i$  to  $\hat{z}_{i+1}$  measured about  $\hat{x}_i$

$d_i$  = Distance from  $\hat{x}_{i-1}$  to  $\hat{x}_i$  measured along  $\hat{z}_i$

$\theta_i$  = Angle from  $\hat{x}_{i-1}$  to  $\hat{x}_i$  measured about  $\hat{z}_i$

There you can see that there is only 2 axis used there have no Y-axis calculation because its link length based on X axis and Z-axis.

The diagrams are



Parameters.

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Ans. to the Q. No-4(b)

According to the scenario we can see two rules that Right Hand Rule and DH parameters. We need to discuss about these two to know about their similarities, dissimilarities and relation.

Right Hand Rule: The Right Hand rule ~~is actually~~ is actually a common technique for understanding orientation of axes in three dimensional space. The three fingers represent the X-axis, Y-axis and Z-axis. That also called Roll, pitch and yaw angles.

The rotation equation of three axis, are,

$$\text{rotate-z}(\phi) = \begin{bmatrix} \cos\phi & -\sin\phi & 0 \\ \sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\text{rotate-x}(\phi) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\phi & -\sin\phi \\ 0 & \sin\phi & \cos\phi \end{bmatrix}$$

$$\text{rotate-y}(\phi) = \begin{bmatrix} \cos\phi & 0 & \sin\phi \\ 0 & 1 & 0 \\ -\sin\phi & 0 & \cos\phi \end{bmatrix}$$

DH - Parameters: DH full form is

Denavit-Hartenberg parameters. These are the four parameters associated with a specific convention for showing frames to the linker. These depend on some link and joint parameters.

$a_i, \alpha_i, d_i, \theta_i$ .

So, the DH techniques are,

$$A_i = \text{Rot}_{z, \theta_i} \text{Trans}_{z, d_i} \text{Trans}_{x, a_i} \text{Rot}_{x, \alpha_i}$$

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$$= \begin{bmatrix} C\theta_i - S\theta_i \alpha_i & S\theta_i \alpha_i & \alpha_i C\theta_i & d_i \\ S\theta_i & C\theta_i & 0 & 0 \\ 0 & S\alpha_i & C\alpha_i & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

We can see both of them can rotate every move, left, right, forward and backward, and also dynamic and electromechanic. But the dissimilarities are right hand rules have 3 axis but DH parameter is based on 2 axis, x axis and z axis. But it have many facility and ~~is~~ better than right hand rule, easier to robot movement.

The advantages and disadvantages of DH parameters are given below:-

Advantages: ~~It can give a stan~~

- i) It can give a standard methodology
- ii) can be defined to represent velocity and acceleration
- iii) It has a simple mechanism.
- iv) It is far easier to automate

Disadvantages:

- i) It is based on two axes
- ii) So there are some information about right hand rule and DH parameter.

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