Review Test Submission: Quiz #1 - Pose and Motion Fundamentals

User	Wataru Oshima
Course	228-CSCI585-01-5528
Test	Quiz #1 - Pose and Motion Fundamentals
Started	9/21/22 7:48 AM
Submitted	9/21/22 8:12 AM
Due Date	9/21/22 11:59 PM
Status	Completed
Attempt Score	82.5 out of 100 points
Time Elapsed	23 minutes out of 40 minutes
Instructions	Take the quiz up to 3 times and your score will be averaged.
Results Displayed	All Answers, Submitted Answers, Correct Answers, Feedback, Incorrectly Answered Questions

Question 1

5 out of 5 points

The Robotic Burger has how many degrees of freedom?

Selected Answer: 2

Answers:

3

2

6

1

Response Feedback: As discussed in class, the Burger has 2 - rotation about the body Z axis and translation in the +/-X direction.

Question 2

5 out of 5 points

It is possible for a mobile robot with an arm for manipulation to have more than 6 degrees of freedom.

Selected Answer: True

Answers: True

False

Response Feedback: Yes - e.g., translation, heading of the base (2-DOF) along with manipulator shoulder, elbow, wrist roll, wrist pitch and gripper closure (6-DOF) with a total of 8 degrees of freedom total.

Question 3

5 out of 5 points

Computing systems used to emulate human vision and visual intelligence exceed the connectivity, speed of signalling, and scale of a human brain fully in all three respects.

Selected Answer: False

Answers: True

False

Response Feedback: Correct - this is false. While computers are getting closer in terms of capability, the one clear advantage human brains have over computers for visual intelligence is a much more richly interconnected brain (more synapses) by far compared to the interconnection of computer logic elements. Computers may have a similar number of logic elements to brains (about 100 billion neurons in an average human brain and 114 billion transistors - https://en.wikipedia.org/wiki/Transistor_count), and much faster signalling, but connection is typically via a bus, rather than direct richly interconnected networks (of 1 trillion synapses in the average brain).

Question 4

5 out of 5 points

Please match each type of sensor to what it best senses below.

Question	Correct Match	Selected Match
Gyros	B. rotation rate about a body axis	B. rotation rate about a body axis
Accelerometers	D. acceleration along an axis	D. acceleration along an axis
Magnetometer	A. orientation of a body in the geomagnetic field	A. orientation of a body in the geomagnetic field
Odometer	C. wheel rotation	C. wheel rotation

All Answer Choices

A. orientation of a body in the geomagnetic field

B. rotation rate about a body axis

C. wheel rotation

D. acceleration along an axis

Response Feedback: Yes, as described in Week 4, slide 11 & 12.

Question 5

2.5 out of 5 points

Match the common terms used to descirbe pose for various robotic platforms from below that fit best in terms of completeness and accuracy of the description.

Question	Correct Match	Selected Match
Orientation of an aerial robot.	E. Roll, Pitch, Yaw	E. Roll, Pitch, Yaw
	C. Heading	F. Wheels on the ground

Orientation of a ground mobile robot on a flat surface with no steering.		
Position of an aerial robot.	✔ D. Latitude, Longitude, Altitude.	✔ D. Latitude, Longitude, Altitude.
Pose of a ground mobile robot.	✔ A. Latitude, Longitude, and Heading.	✖ C. Heading

All Answer Choices

A. Latitude, Longitude, and Heading.

B. Banking right

C. Heading

D. Latitude, Longitude, Altitude.

E. Roll, Pitch, Yaw

F. Wheels on the ground

G. Descending

Question 6

0 out of 5 points

The pose of a robotic system must be specified as the rotation of a body frame compared to ECEF (or equivalent) and the translation of the robot's body fixed frame from the ECEF origin. While this could be specified as a vector addition/subtraction and series of rotation matrix multiplications, we most often want a location (latitude, longitude, altitude) and orientation rather than just the cartesian vector transformations.

Selected Answer: ✖ False

Answers: ✔ True

False

Response Feedback: As noted in class, pose is simply the translation and rotation of a body frame relative to an inertial. However, we have yet to study "localization", which translates a cartesian pose into more useful geodetic coordinates and orientation such as heading, pitch and roll, so for now, we might compare to an ECEN NED reference (noted with tape on the floor).

Question 7

5 out of 5 points

Given the sum of 2 vectors, used to model translation of a body frame in an inertial, what is the best answer for:

$$\begin{bmatrix}0\\1\\2\end{bmatrix} + \begin{bmatrix}0\\1\\2\end{bmatrix}$$

Selected Answer:

$$\begin{bmatrix}0\\2\\4\end{bmatrix}$$

Answers:

$$\begin{bmatrix}0\\1\\0\end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 2 \\ 4 \end{bmatrix}$$

Response Feedback: Yes, see Week-2, slide #5.

Question 8

5 out of 5 points

The 3 types of information that fully describe the pose of any robot (arm, mobile, aerial, submersible) are what?

Selected Answers: Orientation (attitude)

Position (location)

Answers:
- ✔ Configuration
- ✔ Orientation (attitude)
- ✔ Position (location)
- ✔ Configuration
- Altitude
- Reachability
- Articulation

Response Feedback: Correct - as discussed in class, a full pose is Position (location), Orientation (attitude), and Configuration. Configuration is for example whether an aircraft has landing gear extended or a robot arm has an shoulder joint that is rotated on its base, etc.

Question 9

5 out of 5 points

If we have acceleration, and we intend to integrate the measured acceleration to get velocity, what do we need to know?

Selected Answer: ✔ Acceleration(t) and initial velocity Vo

Answers:
- Initial Position Po and Acceleration(t)
- Initial acceleration Ao and the Acceleration(t)
- Acceleration(t)
- ✔ Acceleration(t) and initial velocity Vo

Response Feedback: Yes, as discussed in class, when we integrate we need to know the function we are integrating as a function of time and we need to know the initial condition for the anti-dervative - e.g., Vo which is the constant that is otherwise unknown when integrating Acceleration(t)

Question 10

5 out of 5 points

Vector and matrix math notation can be used with all the usual arithmetic operator equivalents (+, -, x, and \ division) as seen with MATLAB. Addition and subtraction are used to model translation of a body coordinate system, multiplication to rotate a vector (e.g., a rigid body fixed coordinate system in an inertial), but division is used most often to solve for unknowns in a linear relationship as we saw in the MATLAB notes.

Given:

$$\begin{bmatrix} 5 & 3 \\ 7 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 10 \\ 14 \end{bmatrix}$$

What is the value of x and y?

Selected Answer: x=2, y=0

Answers:

x=0, y=0

x=2, y=2

x=0, y=2

x=2, y=0

Response Feedback: Yes, as noted in class, we can solve the 2 equations and 2 unknowns with algebraic substitution or with matrix inversion using MATLAB. See Week 3, slide # 11.

Question 11

5 out of 5 points

There is really no such thing as a truly inertial reference frame (non-accelerating coordinate system) since the Earth rotates around its axis and around the Sun, but we ignore the minor accelerations due to earth rotation (centripital) and corriolos. We simply approximate an inertial system with an Earth Centered, Earth Fixed inertial reference.

Selected Answer: True

Answers:

True

False

Response Feedback: Yes, as noted in class and the book.

Question 12

5 out of 5 points

Using the Right-Hand rule and a body fixed coordinate system for the Burger, which one of the following is always true in normal operation?

Selected Answer: The +Z direction is down into the floor.

Answers:

Rotation about the X axis orients the Burger on a new heading.

The +Z direction is down into the floor.

Translation on the X axis is only possible in one direction.

Rotation about the Y axis orients the Burger on a new heading.

Response Feedback: Yes, by the RIgh-hand rule, the +Z is down toward the center of the Earth (floor). The burger can rotate around the Z axis to re-orient.

Question 13

5 out of 5 points

Robotics as presented in class and described by Corke in our text can include a wide variety of systems that use sensors and actuators to automate or autonomously complete a wide range of tasks either with human interaction and supervision, or fully on their own. Given this broad definition, please select all examples (multiple answers) that would be conidered to be robotic.

Selected Answers:

A mobile 2 degree of freedom 2 wheeled platform that maps indoor spaces using LIDAR (Light Detection and Ranging).

An industrial machine that can stand in for and replicate human actions such as a welding system used on an automotive assembly line.

A UAV "drone" that maps the path of a river flying above it.

A deep space probe that takes images of Jupiter and relays them back to Earth.

Answers:

A mobile 2 degree of freedom 2 wheeled platform that maps indoor spaces using LIDAR (Light Detection and Ranging).

An industrial machine that can stand in for and replicate human actions such as a welding system used on an automotive assembly line.

A UAV "drone" that maps the path of a river flying above it.

A deep space probe that takes images of Jupiter and relays them back to Earth.

Response Feedback: Yes - all of the above can be considered to be "robots". Wikikpedia - The word *robotics* was derived from the word *robot*, which was introduced to the public by Czech writer Karel Čapek in his play *R.U.R. (Rossum's Universal Robots)*, which was published in 1920. The word *robot* comes from the Slavic word *robota*, which means work/job. Corke would agree that there are a wide range of systmems that can be called robots, with the common characteristic that the have sensors and actuators that along with programming can do work or complete tasks. For CSCI 585, we agree with this general definition as does IEEE RAS (Robotics and Automation Society). The difference between automation and robotics might be a bit more nuanced, but robots usually are differentiated by the ability to complete tasks similar to or in place of a human or working with a human. Less trivial tasks than simple automation such as a machine that puts bottle caps on bottles (could pehraps be debated).

Question 14

5 out of 5 points

We are using ROS in class and working around some limitations of the NVIDIA Jetson Nano 2g, Ubuntu versions (18.04, 20.04, etc.) and ROS vs. ROS2. Please match the following recommended versions ROS and ROS2 to Ubuntu distributions based upon Robotis documentation and our class recommendations.

Question	Correct Match	Selected Match
What version of Ubuntu should you use in CSCI 585 for ROS Melodic?	H. Ubuntu 18.04 LTS Host OS	H. Ubuntu 18.04 LTS Host OS
Which alternate board is best for Computer Vision apps and runs JetPack 4.6 and ROS2 best?	E. Jetson Nano 2g	E. Jetson Nano 2g
What is the version of the SBC that comes with the Burger?	D. Raspberry Pi 3b	D. Raspberry Pi 3b

What version of ROS2 should be used with the Jetson Nano 2g?	I. Dashing	I. Dashing

All Answer Choices

A. Ubuntu 22.04 LTS Host OS

B. Foxy

C. Jetson Nano 4g

D. Raspberry Pi 3b

E. Jetson Nano 2g

F. Kinetic

G. Noetic

H. Ubuntu 18.04 LTS Host OS

I. Dashing

Response Feedback: Correct - we are using:

1) R-Pi 3b with ROS Melodic and Ubuntu 18.04 LTS Host

2) R-Pi 4b or Jetson Nano 2g running JetPack 4.6 with ROS2 Dashing and Ubuntu 18.04 LTS

Question 15

0 out of 5 points

For CSCI 585 Robotics with the Burger mobile robot, we use a body fixed local coordinate system and measure heading and travel forward/backward relative to the NED ECEF inertial refernce frame using the Left-Hand rule.

Selected Answer: True

Answers: True

False

Response Feedback: No, as agreed upon in class, we determine pose of the body with respect to NED ECEF - with the Right-Hand rule!

Question 16

5 out of 5 points

Select the best answer for the following vector matrix multiplication (commonly used to rotate a vector).

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 2 \\ 0 & 2 & 4 \end{bmatrix} \mathbf{x} \begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix}$$

Selected Answer:

$$\begin{bmatrix} 0 \\ 5 \\ 10 \end{bmatrix}$$

Answers:

$$\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 5 \\ 10 \end{bmatrix}$$

$$\begin{bmatrix} 10 \\ 5 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 10 \\ 5 \end{bmatrix}$$

Response Feedback: Good - as we see on slide 8, week 3.

Question 17

5 out of 5 points

Note all valid alternatives for estimation of pose orientation (attitude) compared to the rotation matrices we studied and plan to use.

Selected Answers: Euler angles

Quaternions

Answers: Euler angles

Tensors

Scalars

Quaternions

Response Feedback: Yes, quaternions and Euler angles are explained as alternatives in Corke.

Question 18

5 out of 5 points

Match each of the rotation matrics to the axis of rotation.

Question	Correct Match	Selected Match
$\begin{bmatrix} 1 & 0 & 0 \\ 0 & cos(\theta) & -sin(\theta) \\ 0 & sin(\theta) & cos(\theta) \end{bmatrix}$	A. Rotation about X	A. Rotation about X
$\begin{bmatrix} cos(\theta) & 0 & sin(\theta) \\ 0 & 1 & 0 \\ -sin(\theta) & 0 & cos(\theta) \end{bmatrix}$	C. Rotation about Y	C. Rotation about Y
	B. Rotation about Z	B. Rotation about Z

$$\begin{bmatrix} cos(\theta) & -sin(\theta) & 0 \\ sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

All Answer Choices

A. Rotation about X

B. Rotation about Z

C. Rotation about Y

Response Feedback: Yes - as noted in Week 2 slides, page 6.

Question 19

5 out of 5 points

While rotation of a vector by an abitrary amount around an axis requires the use of transcendental functions (sine and cosine), rotation by orthogonal amounts can be completed with a transpose and pivot.

Selected Answer: True

Answers: True

False

Response Feedback: Yes, as noted in class and shown by example with this code - https://www.ecst.csuchico.edu/~sbsiewert/csci585/code/Mat-rotate/

Question 20

0 out of 5 points

If we have an incremental position encoder and no IMU, assuming minimal wheel slip, and known wheel geometry, what method allows us to best estimate velocity?

Selected Answer: The integral of Acceleration(t) with a known initial velocity Vo

Answers:

The integral of Acceleration(t) with a known initial velocity Vo

The integral of Acceleration(t)

The derivative of Acceleration(t)

The derivative of Position(t)

Response Feedback: Without an IMU (that measures acceleration), we can estimate velocity by taking the time derivative of Position(t) as measured by the incremental wheel encoder.

Wednesday, September 21, 2022 8:12:21 AM PDT

← **OK**