Fall23 CSE461: MID-term

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Question 1

In a rapidly aging society where the elderly population is increasing, a state-of-the-art Elderly Care Companion Robot is introduced to provide physical and emotional support to seniors. This friendly and versatile robot is designed to enhance the quality of life for elderly individuals while enabling them to age in place comfortably and independently. The robot is capable of understanding and responding to voice commands, engaging in natural conversations, and offering companionship through conversation. It can dispense medication at scheduled times and remind the elderly individual to take their pills, ensuring they adhere to their prescribed regimens. The robot can detect when an elderly person has fallen and offer assistance by alerting caregivers or helping the individual get back on their feet. In case of emergencies, the robot can trigger alerts to medical professionals or family members, providing critical assistance.

Answer the following questions based on the given scenario. You **MUST** write your answers on paper.

(a) **Which** sensors should be used, and for what purposes? **[2 Marks]**
(b) **Which** actuators should be used, and why? **[2 Marks]**
(c) **What** kind of processing device should be used, and why? **[2 Marks]**
(d) **Which** paradigm should be followed to develop the robot and why? **[2 Marks]**
(e) Briefly discuss the Primitives of a traditional robotic system. **[2 Marks]**

Question 2

Answer the following questions on this form. Each question might contain multiple correct answers, so pick all that apply.

✕ Which paradigm is represented by the following figure ? **[1 Marks]**
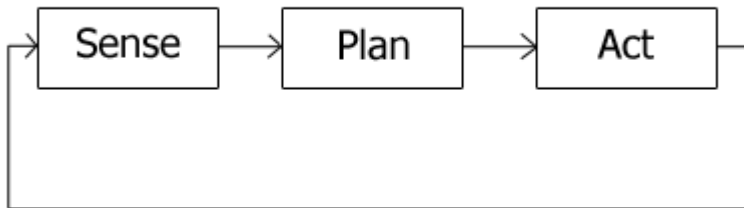
☑ Hierarchical Paradigm ✓

☐ Deliberative Paradigm

☐ Reactive Paradigm

☐ Hybrid Paradigm

Correct answer

☑ Hierarchical Paradigm

☑ Deliberative Paradigm

✓ Which of the following is not a Law of Robotics ? **[1 Marks]**

☐ A Robot may not injure a human being

☐ A Robot may not allow a human being to come to harm

☑ A Robot may not leave a human jobless ✓

☐ A Robot must have a kill switch

✕ A devastating fire broke out at a chemical warehouse. The Fire Department decided to deploy their intelligent autonomous robots for search and rescue operation. After assessing the situation, the robots informed the human operator that the robots will be unable to withstand the extreme temperatures inside the warehouse. Ignoring their assessment, the operator instructed the robots to enter anyway, and they obligned. Most of the robots malfunctioned immediately after entering the warehouse.
Based on your understanding of the laws of robotics, which of the following options do you think are correct ? **[2 Marks]**

- [ ] The robots took the correct decision without violating any laws
- [ ] The robots took the incorrect decision as it violated the third law of robotics
- [x] The robots took the correct decision following the second law of robotics ✓
- [ ] The robots took the incorrect decision as it violated the second law of robotics
- [x] None of the options are correct ✕

Correct answer

- [x] The robots took the correct decision without violating any laws
- [x] The robots took the correct decision following the second law of robotics

✓ Select correct statements on Sensors. **[2 Marks]**

- [x] Sensors are used to perceive the surrounding world of a Robot ✓
- [ ] Passive sensors require emitter as it use passive physical properties for sensing
- [x] Sensing materials are very limited but we can build sensor by doing engineering ✓
- [ ] Ultrasonic sensor requires to emit light after triggering signal. As soon as it received the reflected optical pulse, it stopped the clock and calculate distance by (speed * time / 2)
- [ ] LIDAR use high speed acoustic wave burst. After reflecting off an object, the echo return. Flight time then converted to distance.
- [x] Both IR and Sonar can be used for proximity sensing. One use acoustic sound another use infrared light. ✓

✗ Select statements for Control Sub-systems that are false. **[2 Marks]**

- [x] Arduino is better for research and development but micro-controllers are better for product development. ✗
- [ ] Single board computers like Raspberry PI are mainly build by a micro-controller based system on a chip but it can interface sensors directly.
- [ ] RaspberryPI is a credit card size computer that can both process huge data like camera image on the other hand it can be interfaced with GPIO.
- [x] RaspberryPI is better than Jetson Nano in machine learning based applications. ✓
- [ ] If we compare Arduino with Raspberry PI, Raspberry pi requires more power although both of them can be interface with Digital IO.

Correct answer

- [x] Single board computers like Raspberry PI are mainly build by a micro-controller based system on a chip but it can interface sensors directly.
- [x] RaspberryPI is better than Jetson Nano in machine learning based applications.

✗ Select statements for Motion Sub-systems that are false. **[2 Marks]**

☐ Gears and belt-pulley both can reduce and enhance speed and force (torque).

☑ Pneumatic actuator use lubricant on the other hand Hydraulic actuator use air compression that why Pneumatic actuators are more powerful than Hydraulic actuators ✓

☑ Electric actuator can beat both pneumatic and hydraulic actuators by efficiency, reliability and operational cost. ✗

☐ In every aspect DC motor is better but speed and torque are the issue that can be defended by a gearbox and feedback system.

☑ Stepper motors are close-loop motor that can reach to any angle step by step using PWM signal. ✓

☐ Servo motor is nothing but a DC motor having a gearbox and feedback system that have a comparator and control system to use PWM.

Correct answer

☑ Pneumatic actuator use lubricant on the other hand Hydraulic actuator use air compression that why Pneumatic actuators are more powerful than Hydraulic actuators

☑ Stepper motors are close-loop motor that can reach to any angle step by step using PWM signal.

Question 3

 The manipulator has a base height of 20.84", shoulder length of 28.97", and elbow length of 13.48". Answer the following questions:

(a) To go to Position 01, if the base rotates 58.77°, the shoulder moves 25.41°, and the elbow moves 70.5° then find the final coordinate (X, Y, Z) of the end-point of the manipulator. **[5 marks]**

(b) Suppose the (X, Y, Z) coordinates are (11.52, 27.99, 28.44). Find the angle of base rotation, angle of shoulder movement, and angle of elbow movement. **[5 marks]**

Put your answer here but you should have calculation steps in the white paper. No correct answer will be judged without the calculation. On the other hand partial marks can be given based on calculation steps even the answer is wrong.
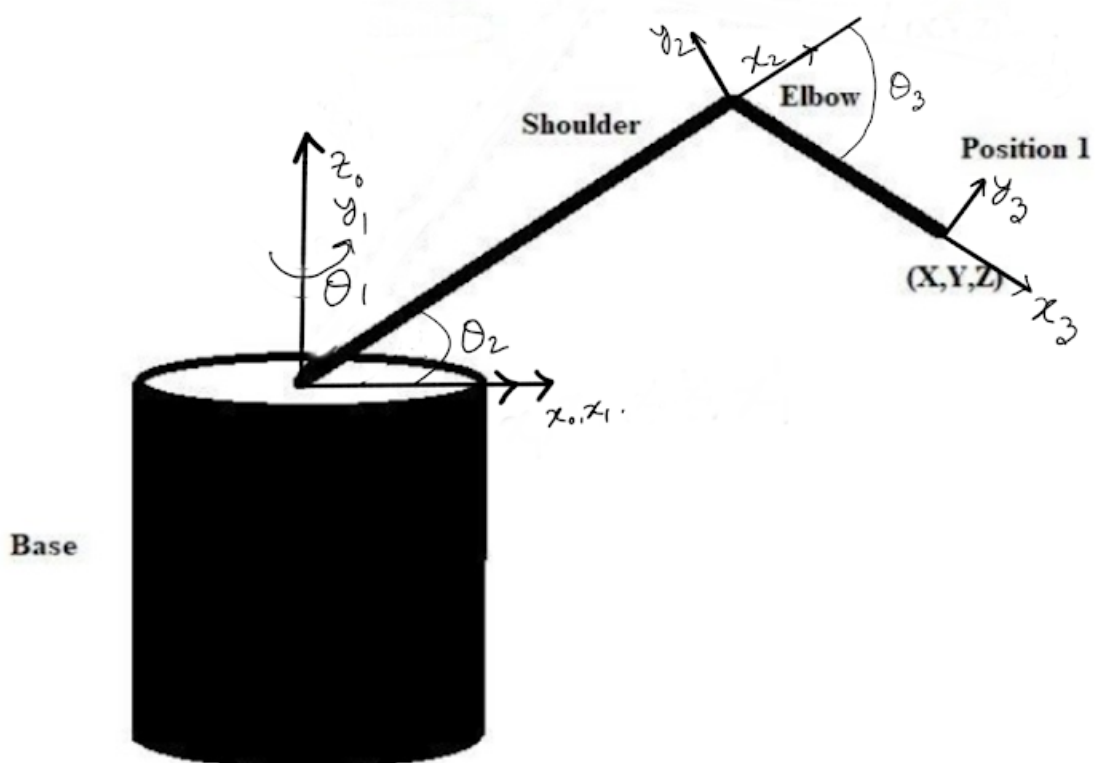
a) joint 1 theta is 58.77 joint 2 alpha 25.41 joint 3alpha 70.5   b) theta 1,2,3 are accordingly 33.41, 93.81, 97.74