UNC Charlotte–ECGR4161/5196-Midterm Exam 1 –2/18/2009

Name: _____ Mosaic User ID _____

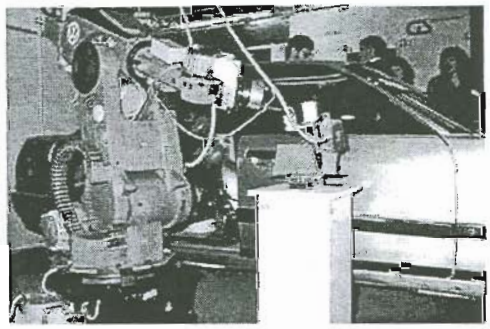
Question	1	2	3	4	5	6	Total
Score	/10	/10	/15	/15	/25	/75	/150

You are permitted 75 minutes to take this test, no more. This is an open book/open notes test. You are allowed the following items for the test: calculator, books, notes, homework, labs, pencils and erasers. You are not permitted to have any of the following on your desk during the test: computer, cell phone, or other electronic assistance. Failure to abide by this policy will result in a zero for the test and a visit to the UNC Charlotte honor board. **Put your answers on paper provided, and turn in this sheet and the answer pages - use only that paper.**

Please read and sign this statement: I have not received from anyone nor assisted others while taking this test. I have also notified the test proctor of any of these violations noted above.

Signature: _____

1. Consider a robotic arm that is used in an automobile manufacturing line. Is this considered an autonomous robot? Why or why not? Write this in 2-3 sentences. (10 pts)



Definition of Autonomous
incorrect -5
Justification -3

2. With respect to Chapter 4, what is the difference between closed loop and open loop systems. Write this in 2-3 sentences. (10 pts)

Lack of detail -5
No mention of sensors -2 or -3

3. Based on class readings and discussion, draw a representation of the biological feedback control system representing remaining standing in a bus that continually pitches and bounces. Be as specific as possible. (15 pts)

5 Sensors: visual, ear, muscle tension (-3 if no mention of biological activation)

5 Control/actuators: muscles (-3 if no mention of biological activation)

3 feed back

2 No reference

4. Consider our Renesas board. Write a small C code function (only the function, not all of the system code) that will turn on all of the LEDs, read the ten bit value at ADC 0, and return "0" if the value is less than 512 and return a "1" if the value is greater than or equal to 512. (15 pts)

2 proc definition w/return
1 Turn on Red
1 Turn on Yellow
1 Turn on Green
2 Read ADC 10 bits
1 Filter lower
2 Return 0 <512
2 Return 1 >511
2 Correct C code
1 Structure

Not needed → setup ADC

5. Choose one video we have viewed in class or one article we have read. Identify the video/article, and then list all of the sensors and actuators associated with one robot in the video/article. BREIFLY describe the function of each of these devices (25 pts)

Identify the source (paper/video) 3pts

List Sensors 4pts

List Actuators 4pts

function of sensors 7pts

function of actuators 7pts

6. Consider you will design an autonomous robot that can sense its environment and move to perform a task. The environment is that a high-tech car repair shop, at a dealership, has a networked computer near each car being repaired. The mechanic can use the computer to look up and order parts for the repair. The parts department will immediately be notified of the order, pull the part(s) (manually) from the storage, and put it on a robot. The robot will deliver the car part(s) to a mechanic on the shop floor and return. The robot will stay with the mechanic until it is "released" (the part may be wrong and may have to be returned to stock. It is envisioned there will be about 100 of these robots in a shop with 100 repair bays (big dealership!).

   Using blank paper, write the requirements for the robot. The requirements should include the type of sensing and motion. It should also include safety considerations. Also identify performance measures for the entire system. You need to write at least 15 requirements. Use your knowledge of requirements from senior design and the labs as guidelines. (75 points)

Typical Requirements to include (5 points each)

Battery
Motors / Motion speed
Sensors to avoid people & other robots
Sensors to read where to go
Make noise so others know where it is
Control panel / device for mechanic
System controls which robot is to be used
Can handle weight of any part
Motion algorithms / path planning

Must include the above at a minimum.

Must use requirements language (-5)

1. It will need to have good traction (oil?)
2. It will need to be able to follow a set path. Nice!
3. It will need to be able to modify its course if the part is overly large or bulky.
4. It will need some sort of RF receiver/transmitter or wifi so it can find base and target mechanic.
5. It will need a particular ID tag so parts don't go to the wrong mechanic.
6. It will need bumper sensors to identify if it hits another object.
7. It will need some sort of course correction software to get around said obstacle.
8. It will need some sort of audio module to announce its movement as well as arrival if mechanic does not notice it.
9. It will need a feedback system in case the part slips or falls off.
10. The robot will need either a button or RF/IR sensor that the mechanic can use to release the robot.
11. It will need control circuitry to differentiate between being released and being sent back for another part if the first was wrong.
12. It should have some sort of optical sensor to help it keep on its set path or possibly to identify hazards.
13. It should keep up constant communication with the server so that two robots don't interfere with each other or possibly collide.
14. It will need fairly robust actuators to handle heavy loads as well as parts being dumped onto it.
15. It should send some sort of emergency signal to server in case it does get tipped over or damaged.

✓ (1) The robots should use a robust wi-fi protocol on the channel with as little interference as possible. This is for the mechanics to communicate with the robots.

✓ (2) The robots should locally broadcast a low-power wireless signal to alert other robots that it is nearby

✓ (3) The robots should reduce its' speed of travel based on how many other robots are in its' proximity.

✓ (4) The robots should be equipped with cameras

✓ (5) The robots should be able to follow white lines that lead to and from repair bays and to and from storage locations.

✓ (6) The robots should be able to read low-power wireless signals that indicate what area/zone it is in so it can find its' way to the proper storage area or repair bay.

✓ (7) Each robot should be pre-programmed with a "map" of all the areas/zones in the entire facility.

✓ (8) Each robot should be capable of avoiding obstacles, including other moving robots

✓ (9) Each robot will be equipped with ultrasonic sensors for obstacle detection

✓ (10) Each robot should be equipped with a mechanical stop button, that shuts it down and turns off power

✓ (11) Each robot will have a a remote electrical stop, capable of being activated from any computer in the facility

✓ (12) Each robot will have a display in order to display part numbers/names to the parts department

✓ (13) Each robot should be able to queue multiple tasks from multiple users

✓ (14) The robots will be capable of returning parts to the supply

✓ (15) Once a robot arrives at its' destination it will not move until signalled.

b) Requirements: NICE!

✓ 1. Microprocessor/controller for controlling its movement and taking commands

✓ 2. A networking device, probably wi-fi so that the robot knows which mechanic to go to and where to pick up parts. It will also need to communicate with a database.

✓ 3. Pressure/load sensors for detecting whether or not a part has been placed on the robot; the weight of the part should also be detected and compared to a database to minimize human errors in the parts department.

Nice!

✓ 4. Stepper motors for movement

✓ 5. The robot should have a memory of the building's layout and should know its position at all times, relative to its destination. Stepper motors ensure this accuracy.

✓ 6. Proximity sensors to adjust its position when unexpected obstacles are present. Can't run over people or knock things over!

✓ 7. Algorithms for repositioning itself after going around an obstacle or going off course.

✓ 8. Actuators for detecting when a human has knocked it off course.

✓ 9. Battery charge sensor so that it can recharge itself at a station

✓ 10. Velocity/acceleration sensors so that it doesn't drop a part. (If built correctly, it should be impossible to drop a part, as the part will be enclosed until given to the mechanic/returned.)

✓ 11. Failure sensor so that it doesn't waste time not doing what it's supposed to do.

✓ 12. A switch for the mechanic to push when finished

✓ 13. A switch for the mechanic to push if wrong part

✓ 14. A compass to ensure its rotation is correct, required for moving in the right direction

✓ 15. Temperature sensor to detect a fire so that it can get out and solve itself!

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Req 1 - The Robot will autonomously move from the order Fulfillment center to a designated location near the repair stall.

Req 2 - The Robot will wait for the mechanic to issue a release command upon reaching the repair stall

Req 3 - The Robot will autonomously move from the repair stall to the order Fulfillment center

Req 4 - The Robot will follow a designated path

Req 5 - A designated path will be identified by RFID tags embedded in the floor at 10 foot intervals

Req 6 - The Robot will be able to read RFID tags embedded in the floor

Req 7 - The Robot will correct its path based on RFID Tag locations

Req 8 - The Robot will stop when an obstacle is on the designated path

Req 8 - The Robot will Recharge while waiting in the order Fulfillment center

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Req 9 - The Robot may recharge while waiting at the Repair station

Req 10 - The Robot must carry a minimum of 50 Pounds

Req 11 - The Robot will use rechargable nickle Metal Hydride batteries

Req 12 - The Robot will operate on a battery voltage of 24 V (Nominal)

Req 13 - The Robot will use a differential drive wheel arrangment

Req 14 - The Robot will use solid rubber wheels on a rim not to exceed 16 inches

Req 15 - The Robot may use Passive Infrared, active infrared, Lidar, ultrasonics, and/or bump sensors to detect obstacles

Req 16 - The Robot will have an emergency stop button on the front, back, and each side

Req 17 - The Robot will have a button for issuing the Release command

Req 18 - The Robot will have a means of communicating its intended destinati

Robot Requirements:

Very nice, except the last one.

REQ01. The robots must have a wireless network connection to know which station to deliver the assigned part(s) to.

REQ02. The robots must have a scanner to detect what part(s) are being given to it.

REQ03. The robots must have a dedicate path for delivery and return.

REQ04. The robots must have a sensor for the mechanic to "release" it back to the storage area. (button or microphone for voice command)

REQ05. The robots must have a turning radius of 0°.

REQ06. The robots must use wheels as a means of motion.

REQ07. The robots must have a camera to sense images in its surroundings.

REQ08. The robots must stop if there is an obstruction and let the parts dept. and mechanic know that it is stopped.

REQ09. The robots must be programmable for shop layout changes and part(s) updates.

REQ10. The robots must have a thermal sensor to sense humans, and give the right-of-way to them.

REQ11. The robots must not exceed speed over 10 mph for safety.

REQ12. The robots must have self-diagnostic error checking.

REQ13. The robots must have a dedicate charging station to which they return when battery life reaches 1/8 full power and at the end of the shift.

REQ14. The robots must be battery operated.

REQ15. The robots must have speakers for communication and alarms.

REQ16. The robots must have a sensor for execution from the parts dept. for when they are done loading the robot.

REQ17. The robots must have a sensor for the mechanic in case of wrong parts delivery.

REQ18. The robots must have lasers they can install on sharks.

Requirements

12/5) The robots will travel along walls to prevent collisions with other robots.

1) The robot will not attack ^ other humans (or harm — so the robot is Human?)
2) The robot cannot take commands that go against Requirement 1.
3) The robot will store parts in protective compartment so no humans will have potential of injuries.
4) The robots will have wheels that are non-skid steered, to prevent slipping in case of slippery floor.
5) Rotary encoders will sense rotation of wheels.
6) Ultrasonic sensors will sense obstacles.
7) The robot will sense the mechanic by RFID chips in the mechanic badge.
8) The robots will have RFID on board so that other robots can sense it.
9) A red light and beeping sound distinct to each robot will be used to identify location of where robot should function.
10) Each robot will have docking bay when not in use where they can be stored for charging.
11) Each robot will run on lithium-ion batteries
12) The robot will be able to communicate to mechanic from parts department via wireless link after deployment with part
13) After part is dropped off to mechanic, the robot will return to docking bay
14) [illegible] to prevent bots stuck in corner