Embedded Real-Time Systems (AME 3623)
Homework 4

April 27, 2012

This homework assignment is due on Thursday, May 3rd at 8:59am (**before class begins**). Your work may be handed in electronically (use the **Homework 4** digital dropbox on D2L) or in hardcopy form (in person or to my office).

This assignment must be done individually: do not share/discuss your answers with others or look at the answers of others.

Question 1

Consider the FSM that controlled our vending machine in class. We wish to add another feature (an "Easter Egg"): if the user inserts three nickels in a row starting from a zero value, then the machine will then be ready to dispense two drinks of the user's choice.

(20 pts) Draw the FSM diagram that describes the behavior of this new vending machine. **Do not add events or actions.**

Question 2

We are designing a control subsystem for a robot foraging task. In this scenario, the robot has a set of blue and green balls scattered around it. Using its camera, the robot can identify whether either type of ball is in front of it or if there are no balls. The robot's task is to gather twice the number of blue balls as green. Here are the rules:

- The robot can observe: no balls (NB), green ball (GB) or blue ball (BB).
- The robot can rotate left (RL) or right (RR). Rotations will result in a change of what the camera can see.
- If the robot has not found a ball in the last one minute of search time, then it must SHUTDOWN.
- The robot can initiate a grasp of a ball of a certain color at any time. The grasp will end in one of two ways: SUCCESS or NoSUCCESS.
  - If the robot is already holding onto a ball, then the result will be NoSUCCESS.
  - If the specified ball color to grasp is not currently being observed, then the grasp action will always end in a NoSUCCESS.
  - If the ball color is currently being observed, then either SUCCESS or NoSUCCESS may arise.
- If the robot is currently grasping a ball, then it may PLACE the object in its on-board basket (freeing it to grasp another object).
- At any time: $|2 \times N_g - N_b| \leq 1$, where N_g is the number of green balls and N_b is the number of blue balls.
- If the robot currently has a balanced number of balls ($2 \times N_g = N_b$), then it must pick up the first ball that it observes.

1. (5 pts) What are the events?

2. (5 pts) What are the actions?

3. (20 pts) Show the states and transitions. Label the transitions with events and actions.

Question 3

Consider a keypad and a locked door with the following properties:

1. The keypad has 4 keys, labeled: 1, 2, 3, 4
2. Entering the sequence: 1, 2, 1, 4 results in unlocking the door
3. Entering the sequence: 4, 1, 1, 4 also results in unlocking the door
4. Entering any key after a door is unlocked will result in the door being locked again. This "locking" key can be the first in the next unlocking sequence.
5. Extraneous button presses result in a resetting of the sequence
6. The first occurrence of the above sequences should result in the unlocking the door (i.e., the sequence 4, 4, 1, 2, 1, 4 will unlock the door as soon as the last 4 is pressed)

We will design a finite state machine that performs this control task. Remember that every state must respond to each event in exactly one way.

1. (10 pts) What are the events?

2. (10 pts) What are the actions?

3. (20 pts) Show the states and transitions. Label the transitions with events and actions.

Question 4

How much time did you spend on this assignment?