

Lab 7: Elliptical Machine User Interface

Description:

In this lab, you will be writing a MATLAB script file to partially model the logic for a user interface for an elliptical machine. A typical elliptical machine allows the user to enter age and weight. We will add a feature allowing the user to enter gender since the formulas for maximum heart rate and calories burned differ for males and females. A typical elliptical machine also has a sensor for heart rate which produces a voltage signal proportional to the user's heart rate, and a sensor for speed which produces a voltage signal proportional to the speed of the elliptical machine. These analog voltage signals would be converted into binary signals and sent into a microcontroller for computations on intensity of the workout, calories burned, distance traveled, and digital displays. Since we don't have any physical sensors (or an elliptical machine), you will just enter in the sensor readings as 8-bit unsigned integers.

Procedure:

1. Go to the recitation folder on the Blackboard metasite and download the m-file template. Save it in whatever you use as your current folder for MATLAB with a filename: **Lab7_YourLastName**. Remember, filenames follow the exact same rules as variables in MATLAB (start with a letter followed by any combination of letters, numbers, and underscores and **no spaces allowed!**)
2. In the template, fill in your name and date where indicated. You might want to wait on the description until you have written the program.
3. As you are writing your code, put comment lines in to indicate what each section of code does. Also, write good prompts to the user for inputs and informative fprintf statements.
4. User Inputs: In your script file
 - Write a *menu* statement to prompt user for gender (male/female)
 - Write an *input* statement to prompt user for age (in years)
 - Write an *input* statement to prompt the user for weight (in lbs)
5. Sensor Inputs: In your script file
 - Write an input statement to enter the 8-bit reading on the heart rate sensor as a *string*. Remember, to enter a string using an input statement requires a second argument in the input function, *'s'*.
 - Write an input statement to enter the 8-bit reading on the speed sensor as a *string*.
6. Test Inputs: The intensity level of a workout is determined by what percentage of the maximum heart rate (MHR) the current heart rate is. Fill in the following table to create a set of test inputs for your program. To get the 8-bit code, use the *dec2bin* function in MATLAB.

Male: $MHR = (205.8 - 0.685 * (Age))$

Female: $MHR = (206 - 0.88 * (Age))$

Gender	Age	MHR (bpm)		Gender	Age	MHR (bpm)
Female	18			Male	18	
% MHR	Heart Rate (bpm)	8 bit code	Workout Intensity	% MHR	Heart Rate (bpm)	8 bit code
55			Low	55		
65			Weight Loss	65		
75			Cardio	75		
85			Anaerobic	85		
95			Too High	95		

Note: OK to round heart rates to the nearest integer

- Determine and Display Current Heart Rate (CHR):** In your script file

 - The heart rate sensor produces an 8-bit unsigned binary number. Converting this number to decimal will give the heart rate in beats per minute (bpm). So, a value of 00000000 would correspond to a heart rate of 0 bpm and a value of 11111111 would correspond to a heart rate of 255 bpm. Use the *bin2dec* command to convert the 8-bit reading on the heart rate sensor to a current heart rate in beats per minute.
 - Display the "Current Heart Rate" to the user using an *fprintf* statement with heart rate shown as an *integer* value. Include units.
- Compute Maximum Heart Rate (MHR):** In your script file

Use a *switch* statement to switch on gender. Compute the maximum heart rate (MHR) for the user depending on gender:

Male: $MHR = (205.8 - 0.685 * (Age))$

Female: $MHR = (206 - 0.88 * (Age))$

- Determine and Display Intensity Level of Workout:** In your script file

Write an: *if elseif elseif elseif else* statement that will *display* to the user the intensity level at which they are currently working out according to the following table:

Level	Current Heart Rate (CHR)
Below Level	$CHR < 60\% \text{ of MHR}$
Weight Loss	$60\% \text{ of MHR} \leq CHR < 70\% \text{ of MHR}$
Cardio	$70\% \text{ of MHR} \leq CHR < 80\% \text{ of MHR}$
Anaerobic (Hardcore)	$80\% \text{ of MHR} \leq CHR < 90\% \text{ of MHR}$
Above Level	$CHR \geq 90\% \text{ of MHR}$

- Test your Program:**

Use the table of values you developed in step 5 to test your program. Test all five inputs under your gender. Test one input under the opposite gender. **Note: you can enter anything that you want for weight and speed sensor reading.** Correct your program if needed to

produce the expected results. Once the program is working correctly, copy the results of two of your tests (using your gender) from the MATLAB command window and paste them in the space below.

Two of the Test Results:

11. Convert the Binary String from the Speed Sensor to a Decimal Value (m.p.h.):

The speed sensor produces an 8-bit unsigned binary number that is proportional to the speed. A value of 00000000 corresponds to a speed of 0 m.p.h. and a value of 11111111 corresponds to a speed of 12 m.p.h. Use the *bin2dec* command to convert the binary string to a number between 0 and 255 then figure out how to convert this value to a speed in m.p.h.

MATLAB Command to Convert 8 bit Speed Sensor Reading to Speed (m.p.h.):

12. Calculate and Display the User's Current Speed: In your script file

- Convert the 8-bit speed sensor reading to a decimal speed in m.p.h.
- Use an *fprintf* statement to display the current speed to the user with *one place behind the decimal point*. Include units.

13. Calculate and Display Calories Burned Per Hour: In your script file

- Compute the calories burned per hour based on the user's inputs and the following formulas.
- Use the *round* command to round calories/hr to the nearest integer.
- Use an *fprintf* statement to display the calories burned per hour to the user as an *integer*.

Male:

$$\text{Cal/hr} = (\text{Age} * 0.2017 + \text{Weight} * 0.09036 + \text{Heart Rate} * 0.6309 - 55.0969) * 60 / 4.184$$

Female:

$$\text{Cal/hr} = (\text{Age} * 0.074 - \text{Weight} * 0.05741 + \text{Heart Rate} * 0.4472 - 20.4022) * 60 / 4.184$$

14. Test Your Program:

Test your program using the test inputs provided in the table below. Correct your program if needed. Once the program is working correctly, copy the results of both tests from the MATLAB command window and paste them in the space below.

Gender	Age	Weight	Heart Sensor Reading	Speed Sensor Reading	Speed (m.p.h.)	Cal/hr
Male	18	165	10010001	01111011	5.8	788
Female	18	125	10001110	10000100	6.2	534

Test Results:

15. If you have not done so already, add comments to your script file to explain what your program does.

To be turned in: your lab document and your script file.