BEN 465/665 Problem 3

Assignment: Use a microcontroller and the Python programming language to develop a wearable assistive technology device that *without the use of individual fingers* can control (1) a computer cursor with both left and right mouse clicks and (2) the WASD & Space keys.

Solution format: You must respond to the following prompts in your solution (see prompt #8 for the details of preparing the written report).

1. *Define* the problem.
   a. What is the problem? What are you looking for? What are you trying to accomplish? What's the goal here?

2. *Explore* the problem and *identify* constraints.
   a. What defines control of a cursor and mouse clicks? *What* needs to be controlled?
   b. What defines control of the WASD and Space keys? *What* needs to be controlled?
   c. Why do you need a microcontroller? What functionality does it provide? What are all the things it can do and which of those might be useful in your solution (and which are likely *not* useful)?
   d. Why do you need Python? What does it enable that the microcontroller alone can't provide?
   e. What are the biomechanical/anatomic systems that might be relevant to achieving your goal? What do you need to know about them to utilize them effectively in your solution?
   f. What do you already know that is relevant to the problem?
   g. What do you need to find out that is not given? (Hint: Consider why do you need this information before spending time getting it. Don't waste time chasing down information you don't need.)
   h. What assumptions, if any, will you make to solve this problem. (Note: you are encouraged to make reasonable assumptions! However, you should ask your instructor about assumptions before proceeding with your solution.)
   i. Identify constraints on your solution, such as time, money, and materials.
   j. Identify criteria for success. What will constitute success? How will you know when you've achieved it?

3. *Generate ideas.* Brainstorm *multiple* possible solutions. Don't immediately proceed with the first approach you think of—ideate and think through *multiple* different ideas before settling on the one you think most promising. Only then should you proceed to the next prompt.
   a. What are the possible solutions you can identify?

4. *Select* the most promising solution and *formulate* a solution algorithm/design concept. Using the most promising idea identified following your ideation in #3, draft a series of steps that clearly bring you from where you are now to the end point you are seeking. If the algorithm/design involves programming, write and justify what the code will do but don't write the code itself (You will start doing that in #5).
   a. What solution do you think most promising? Why?
   b. What steps will be required to get you from your initial thinking about the problem to the solution you have chosen? Be detailed. Identify *all* of the step you can, but you do not need to perform those steps as part of this prompt, you will do so in response to the next prompt.

   You will be required to submit the results of Prompts 1–4 to be graded before going on to the preparation of your prototype. You may also consult with and get feedback from the instructor at any point in this process.

5. *Prototype.* Create a draft of the solution/product by working through all of the steps of the solution algorithm/design concept of #4 revising and adjusting along the way as needed.
   a. Document the creation of your prototype: save well-commented code; take pictures or create diagrams of your hardware; document sources used (citations); etc.

6. *Test and evaluate* your prototype.
   a. *Before* you begin testing, write up the methodology you're going to use. Your writeup should describe and explain *how* you are going to test your prototype and identify what would represent a successful test outcome versus an unsuccessful one.
   b. Is your solution/design reasonable? Does it *fully* address the design goals? Does it do so minimally or does it do so *well*?
   c. Are there aspects that are not functional and obviously need to be fixed? Are there aspects that may work but could possibly be improved?

d. Is it reliable? Can it be easily broken or caused to fail/crash? Are their special cases or conditions that cause it to not perform as desired?
e. Have you thoroughly checked your calculations and/or code for accuracy, consistent units, bug-free execution, etc.?
f. Have you made assumptions in your design, calculations, or programming that are questionable?
g. Is there a possibility that a better solution might exist if enough time and effort were spent looking for one? (Hint: Yes!) How might you go about finding it?

7. *Iterate* to improve your prototype. Review what was learned in response to prompts 1–6 and repeat any and all prompts to achieve success and the best design considering the constraints within you must work.
   a. Document the iteration process. Explain what changes were made *and why*.

8. *Communicate* your solution to the intended audience(s). For the purposes of this course-based design project, this means preparing your solution in clear written format with the following guidelines:
   a. Within this Word document, address all of the required components identified by the prompts (1-7) of the Solution Format. Do not write an essay. Enter your responses/answers to each prompt immediately after that prompt (e.g., type a response after 1a, then after 2a, then after 2b, etc.).
   b. Make sure the reader will be able follow what you did and *why* you did it. Use clear, grammatically correct, carefully proofed sentences and, if needed, paragraphs. Use images (pictures, diagrams, flowcharts, etc.) wherever they would improve your ability to respond to the prompt, but do not include them just as eye candy.
   c. The report must not exceed 5 single-spaced pages (the 5-page limit excludes references and any cover page you might add, but includes any figures or other materials). Use the font and page layout of the template (Cambria 10 with 0.5" top/bottom margins and 0.75" left/right margins).

9. *Reflect* on what you have learned.

   The following reflection does not count toward the 5-page report limit. Enter your responses below each prompt. There is no page limit, but be as concise as possible.

   Overall assessment: On a scale of 0 to 100, what grade would you give yourself on your solution to this assignment? Explain your answer.

   Technical Content
   a. What are you proudest of in terms of your technical work? What did you do particularly well?
   b. Where do you think there might be weaknesses or errors in your technical work? Are there still technical questions that you have? How would you find answers to those questions if you had more time?

   Problem Solving and Teamwork
   a. What was the most serious problem that you had completing the assignment? How did you deal with it? How will you avoid or minimize similar problems the next time around? Should the instructor do more to help and, if so, what would you suggest?
   b. What, if anything, did you learn about problem solving by working through the assignment? If you did not learn anything, why do you think the experience failed to help you develop problem-solving skills and what would have been helpful?
   c. What worked well for you in your groups? What issues or problems did you have?

10. *Demonstrate* your solution/product.

    During the final two classes of this problem, you will demo your solution/product:
    - *During the next to last class, all teams will have their solution/product set up for other teams and the instructor and TA to try out.*
    - *During the last class, teams will compete in online, browser-based games to unlock achievements (extra-credit).*
      - *Patience is a Virtue Achievement: Using your solution/product's cursor control functionality, reach #1 on the Hexar leader board: http://iogames.space/hexar-io (+5% added to final project score)*
      - *Blockbuster Achievement: Using your solution/product's WASD/Space functionality to score more than 5,000 points in Tetris: https://tetris.com/play-tetris (+5% added to final project score)*

- *Geometry Rules Achievement: Use your solution/product's full cursor and key functionality to attain a Level 15 tank in Diep: https://diep.io (+5% added to final project score)*

Problem Milestones and Schedule

The following milestones *must* be met in solving the problem.

Thursday, November 21st: Share your solution algorithm/design concept (Prompt 4) with the instructor or TA for feedback by the end of class. You can request feedback on your approach *prior* to this class by email, in an earlier class, or during office hours. When sharing your approach, you should be prepared to briefly summarize the approach and to answer questions about any part of Prompts 1 through 4. *It is strongly recommended that you prepare the information you plan to share in the form of a preliminary/rough draft of the complete draft you'll need to be submitting in a few days (see next item).*

Tuesday, December 3rd: Upload a complete draft of your report (Prompts 1–8) for feedback (by another team) by 11:59 pm. Your report must be submitted in a Word file or another widely accessible file format (e.g., PDF) with **the title "Group X" (X = your team number)**. Your CircuitPython file and any other files required for proper functioning of your program (e.g., libraries) should also be uploaded. The team reviewing your report should be able to install and run your code on their CircuitPlayground Express board and to configure their board in the way you have designed (e.g., use of alligator clips or other accessories should be clear).

Also, your team must be ready to demo their solution/product by the beginning of class. Your solution/product should be hooked up to one of the classroom laptops with Hexar, Tetris, and Diep open in different browser tabs for the instructor, TA, and students to try out.

Wednesday, December 4th : Your feedback to the team to which you were assigned to provide feedback must be uploaded by 11:59 pm. **The title must be in the following form: "Feedback for Group Y by Group X" (example: Feedback for Group 15 by Group 16).**

Sunday, December 8th: "Freeze" your final report (Prompts 1–9) and solution/product and upload all files (including all .py files) by 11:59 pm. (Please note, you are welcome to keep improving your solution/product up until the last day of the project, on which you'll compete for the extra credit. If you modify your code between this "frozen" submission and the day of extra credit competition, send the updated code to the Instructor and TA after class that day.)

Resources

The instructor and TA are available to answer any questions you have during class, during office hours, or by email, and the instructor will also provide lectures-on-demand as described in the syllabus. *How to respond to questions and which topics to lecture on and which to hold off on remain at the discretion of the instructor.*

Students also should make use of any and all outside resources they feel would be useful: textbooks, journal articles, and library resources. *Any sources used should be appropriately acknowledged (cited) when a team presents, and every team member should understand all aspects of what the team presents, regardless of the informational sources used. This is a problem for your team to solve, so insights from the work of other teams should only come during in-class discussions and when another team provides feedback on your draft presentation.*

Assessment

Your grade on the problem will be an average of the following components:

A. Assessment of in-class activities. (20 % of total project grade)
B. Assessment of the solution algorithm/design concept you present by November 21st. (10 % of total project grade)
C. Assessment of whether you upload draft materials ready for peer feedback by December 3rd. (10 % of total project grade)
D. Assessment of the feedback/questions you provide to another team by December 4th. **In addition, the presence and participation of your team during all presentational activities during the last two classes of this project will be considered.** (10 % of total project grade)
E. Assessment of whether you upload your final draft by December 8th. (10 % of total project grade)

F. Assessment of the final report uploaded by December 8th and accompanying demo on December 3rd (40 % of total project grade)

Any extra credit (up to 15 % of total grade) achieved in class during the last day of the project will be added to the sum of components A-F.)

As mentioned in the syllabus, peer evaluation of each team's members conducted after completion of the problem will be used to scale the problem grade up by as much as 10 % of the total and down by as much as 100 % of the total (assessed via CATME).

Grades will not be assigned and this problem will remain incomplete until all microprocessor hardware and accessories checked out to the team have been checked back in and found to be in working order.

Assessment Rubrics

The rubrics below will be used to assess (and assign a grade to) each of the assessment components defined above:

A. In-Class Activities		
A Activity successfully completed before end of class during which activity was assigned. 10 % toward total project grade	B Activity successfully completed before beginning of next class (as demonstrated at TA office hours). 9 % toward total project grade	F Activity not successfully completed before beginning of class following that during which the activity was assigned. 0 % toward total project grade
Total Possible from In-Class Activities = 10 % x 2 activities = 20 % toward total project grade		

B. Solution Algorithm/Design Concept Formulation (Definition, Exploration, Idea Generation, Selection and Formulation)		
Grade	**Description**	**Result**
Check	Solution algorithm/design concept addresses each of the components of Prompts 1–4	Full credit – 10 % toward total project grade
Check minus	Solution algorithm/design concept that fails to meet one or more of the components of Prompts 1–4	Partial credit – 6 % toward total project grade
0	Not submitted	No credit – 0 % toward total project grade

C. Draft Upload				
A Draft submitted is complete, submitted in required file formats. 10 % toward total project grade	B A few minor, possibly superficial, deficiencies in completeness of draft exist that may modestly reduce the ability of the reviewing team to provide meaningful feedback. 8 % toward total project grade	C Many minor deficiencies in completeness of draft exist that will obviously reduce the ability of the reviewing team to provide meaningful feedback. 6 % toward total project grade	D Major deficiencies in completeness of draft exist that will substantially reduce the ability of the reviewing team to provide meaningful feedback, such as missing sections or files. 4 % toward total project grade	F No materials uploaded on time. 0 % toward total project grade

D. Feedback				
A Feedback provided to the other team is comprehensive (touching on each of the components of the report) and meaningful (comments aren't just trivial suggestions that require little or no thought). Should be helpful to the other team. All team members present and participating during last two classes of the project. 10 % toward total project grade	B Feedback is less than complete (doesn't touch on everything) or somewhat trivial in nature. Will probably be helpful to the other team. All team members present and participating during last two classes of the project. 8 % toward total project grade	C Feedback is obviously spotty (only touches on a few aspects of report) or and may seem fairly trivial. May or may not be helpful to the other team. All team members present and participating during last two classes of the project. *~or~* *If all team members are not present and participating during last two classes of the project, a C is the maximum possible grade.* 6 % toward total project grade	D Feedback is not meaningful and unlikely to be helpful to the other team. All team members present and participating during last two classes of the project. 4 % toward total project grade	F Feedback is not meaningful and unlikely to be helpful to the other team. All team members not present and participating during last two classes of the project. 0 % toward total project grade

E. Final Draft/Report Upload	
A Final materials are uploaded on time. 10 % toward total project grade	F Final materials are not uploaded on time. 0 % toward total project grade

F. Final Report		
Grade	**Description**	**Result**
A	• Solution/design fully addresses the assignment goals (both cursor and key control) • Solution/design functions as intended when demonstrated during next to last class • Report includes complete responses to all prompts • Reflection is complete and thoughtful	40 % toward total project grade
B	Any two of the following: • Solution/design mostly addresses the assignment goals but is lacking in some minor functionality (e.g., cursor and key control is included but cannot be used simultaneously) • Solution/design functions mostly as intended when demonstrated but suffers from minor errors, bugs, or unintended performance that differs from that intended • Report addresses most but not all prompts • Reflection is not fully complete or thoughtful	35 % toward total project grade
C	Any two of the following: • Solution/design does not address one of the assignment goals (e.g., not all WASD & Space key controls are included) or is lacking in multiple aspects of minor functionality • Solution/design exhibits some level of functionality but does not function as intended when demonstrated • Report is significantly incomplete • Reflection is neither complete nor thoughtful	30 % toward total project grade
D	Any three of the problems listed under C or any one of them present to an extreme degree	20 % toward total project grade
F	All four of the problems listed under C or any two of them present to an extreme degree	0 % toward total project grade

Final grade = sum of all scores from rubrics above.
Total possible from assessment = 100 %.
Up to 15 % extra credit can be earned during the last class (see Prompt #10), making a final score of up to 115% possible.