Spring 2022 Senior Project

Weekly Status Report

Mind Games

https://github.com/knotekbr/cs475_capstone

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WEEK 11 (APR 11 - APR 18)

A. Weekly Accomplishments
B. Problems/Issues

No new problems to report, work is still currently being done on refining the accuracy/efficiency of demonstrating the product.

C. Next Week's Planned Work
   1) Jack, Brandon, and Walid will continue to write the final paper draft.
D. Time Log
   1) Brandon - 1 hour
   2) Jack - 1 hour
   3) Walid - 1 hour

WEEK 10 (APR 4 - APR 11)

A. Weekly Accomplishments
   1) Jack completed midterm demonstration powerpoint. (2 hours)
   2) Brandon completed finalization of software for midterm demonstration. (2 hours)
B. Problems/Issues
   1) Accuracy and expediency of EEG pipeline needs to be refined. During the demonstration, it took too much time to switch between instructions given by the user, even though in the output chart it seemed to be working properly up until that point. This is likely the last development step that needs to be completed, once it is done development will be done so the schedule is still on track.
C. Next Week's Planned Work
   1) Jack, Brandon, and Walid will work towards and present for the SPIRE presentation.
   2) Brandon and Jack will continue further refinement and testing of end-to-end pipeline to enhance accuracy.
D. Time Log
   1) Brandon - 3 hours
   2) Jack - 3 hours

3) Walid - 3 hours

WEEK 9 (MAR 28 - APR 4)

A. **Weekly Accomplishments**
   1) Brandon and Jack have completed a midterm demonstration powerpoint and formulated a plan for the physical demonstration. (2 hours)
   2) Jack completed various training sessions created by Brandon with the headset to determine which physical movements result in the most accurate signal processing. (1 hour)
B. **Problems/Issues**
   1) The consistency of the signal processing is lacking. Essentially, one testing module produced can accurately interpret some instructions given by a user, but others completely miss the mark on all of them. To have a working demonstration for the midterm, we may focus on getting a few signals (out of 5 necessary instructions) correct.
C. **Next Week's Planned Work**
   1) Walid will undergo a different training module in preparation for the midterm demo in which Jack and Brandon will be doing more of the technical presenting.
   2) Brandon and Walid will sharpen the accuracy of the signal processing pipeline.
D. **Time Log**
   1) Brandon - 3 hours
   2) Jack - 2 hours
   3) Walid - 2 hours

WEEK 8 (MAR 21- MAR 28)

A. **Weekly Accomplishments**
   1) Brandon has completed a training module to teach trigger motions to the machine learning pipeline. Currently, training uses a left arm raise, right arm raise, jaw clench, and hard blink for left, right, down, and up, respectively. (1 hour)
   2) Team completed several training sessions to test and analyze the accuracy of machine learning models. (1 hour)
   3) Brandon has been experimenting with multiple versions of the existing machine learning pipeline in an effort to increase classification accuracy. (2 hours)
B. **Problems/Issues**
   1) Developing an effective machine learning pipeline in NeuroPype has proven to be difficult. So far we are able to correctly classify the neutral, up, and down states, but the pipeline often fails to distinguish between left and right. We are experimenting with different trigger motions and pipeline designs, and have been seeing incremental improvement.
C. **Next Week's Planned Work**
   1) Jack will continue to work on the midterm demonstration, and complete additional, more accurate training with the headset.
   2) Brandon and Walid will connect the Flask backend to NeuroPype to enable communication between the headset and the game.

       3) Brandon will continue to refine the machine learning pipeline.
- **D. Time Log**
  1) Brandon- 4 hours
  2) Jack- 2 hours
  3) Walid- 2 hours

WEEK 7 (MAR 14- MAR 21)

- **A. Weekly Accomplishments**
  1) Brandon completed a probability output using NeuroPype. Instead of a difference of a small amount between EEG measurements determining the instruction executed, it is dependent on a likelihood of accuracy. (1 hour)
  2) Jack has compiled research to be used in midterm demonstration, and beyond to improve efficiency and understanding. (.5 hours)
- **B. Problems/Issues**

  No problems/issues to report for this week

- **C. Next Week's Planned Work**
  1) Walid and Brandon will utilize an LSL (Lab Streaming Layer) application to record calibration data, to measure the difference in Jack's EEG readings from the average person.
  2) Jack will enable the completion of training for each possible game instruction through physical movements in the headset.
- **D. Time Log**
  1) Brandon-   2 hours
  2) Jack-   1 hour
  3) Walid- .5 hours

WEEK 6 (MAR 7- MAR 14)

- **A. Weekly Accomplishments**
  1) Brandon has successfully run initial EEG livestream using NeuroPype. (1 hour)
  2) Jack and Walid have researched and identified proper threading techniques to allow all segments of our system to run concurrently. (1 hour)
- **B. Problems/Issues**
  1) Actual implementation of NeuroPype techniques has been slow, because it is a relatively unique system. Once we can achieve proper recognition by the software for separate instructions, our system will be complete though, so a small amount of delay is expected to almost finish the project.
- **C. Next Week's Planned Work**

1) Jack and Walid will implement threading techniques to allow the back-end of the Pac-Man game to receive signals from NeuroPype while comparing live user EEG data with training instructions.
2) Brandon will finalize NeuroPype's method for recognizing matching EEG data for game instructions.

D. Time Log
1) Brandon- 2 hours
2) Jack- 1 hour
3) Walid- 1 hour

WEEK 5 (FEB 28- MAR 7)

A. Weekly Accomplishments
1) Walid and Jack produced the first set of personalized EEG test data by having subjects perform repeated movements in appropriate directions. (1 hour)
2) Jack, Brandon, and Walid have initialized NeuroPype, (after receiving licenses) and have begun first steps into training the software to recognize different controller inputs with test EEG data. (1 hour)
3) Brandon completed WebSocket backend for game to connect with BCI. (1 hour)

B. Problems/Issues

No immediate problems to report, but we are only at the beginning of using NeuroPype and a lack of experience may prove to delay development somewhat.

C. Next Week's Planned Work

1) Brandon will work towards connecting all 3 components of our system, (headset, NeuroPype, and game) to ensure they all can interact efficiently to allow for real-time demonstration.
2) Walid and Jack will continue training/developing NeuroPype software to recognize when a user's EEG data indicates one of the cardinal directions.

D. Time Log

Brandon- 3 hours

Walid- 2 hours

Jack- 2 hours

WEEK 4 (FEB 21-FEB 28)

A. **Weekly Accomplishments**
   1) Pac-Man was completed by Brandon. The game is fully functional and includes win/loss termination, 'Pause' and 'New Game' functionality, and an expanded UI that visually displays received input. (6 hours)
   2) Jack, Brandon, and Walid completed research into determining NeuroPype was the best possible option out of other systems for handling our EEG data. (1 hour)

B. **Problems/Issues**
   1) We were unsatisfied with the lack of customizability and efficiency of Neuromore and other existing BCI (brain computer interfacing) applications. This lengthened our development time to find a suitable replacement.
   2) NeuroPype, the system that we ultimately chose for handling our EEG signals, is free for academic use, but requires users to apply for an academic license. We have submitted our applications and are expecting to hear back from the company within three days, so we do not foresee this having a significant impact on our development timeline.

C. **Next Week's Planned Work**
   1) Jack will utilize NeuroPype documentation to determine the structure of the pipeline that we will use for EEG data processing.
   2) Brandon will work on developing a simple Flask backend to act as a local server for our application. This will include WebSocket API integration for constant communication between the front-end and the back-end.
   3) Walid will utilize Neuropype documentation to determine the format that we will use for our EEG data, including appropriate labeling of data points for supervised learning.
   4) Jack and Walid will put into practice the documentation analysis after we receive our NeuroPype licenses, hopefully before Tuesday.

D. **Time Log**

   Brandon- 7 hours

   Walid- 1 hour

   Jack- 1.5 hours

WEEK 3 (FEB 14-FEB 21)

A. **Weekly Accomplishments**
   1) Live EEG data stream from headset to python file completed by Jack. (2 hours)
   2) Pac-Man development was mostly completed by Brandon, bug fixing and optimization left to complete. (5 hours)
   3) Enhanced graphic diagram of project completed for use in future presentations completed by Brandon. (1 hour)

B. **Problems/Issues**
   1) The OpenBCI software Neuromore required being granted access to by the company, there has been a shift to using explicit python code from the OpenBCI documentation. This change may cause some increase in the development life cycle, but it may also serve

as a replacement for TensorFlow's noise reduction since there is a documentation section regarding it.

C. **Next Week's Planned Work**

1) Walid will continue working on finalization of brain wave input processing, to eliminate noise, and will now be utilizing OpenBCI documentation.
2) Jack will research and establish which isolated (noiseless) brain wave will be most useful for controlling a video game. The goal is to transition from an output stream with many constantly shifting numbers, (even without noise) to an output with definitive indications of movement instructions.
3) Brandon will utilize the JavaScript WebSocket API to establish a connection between the game and the Python backend.

D. **Time Log**

Brandon- 6 hours

Walid-   .5 hours

Jack- 4 hours

WEEK 2 (FEB 7-FEB 14)

E. **Weekly Accomplishments**

4) Initial Pong game created by Brandon for testing implemented using Javascript. (4 hours)
5) Pac-Man development started by Brandon, to continue into Week 3 (3 hours)
6) Menu on startup created by Jack to easily navigate between testing and headset environments. (1 hour)
7) Reduction of brain wave noise research done by Walid to allow for parsing of instructions. (4 hours)
8) Selection of software handler by Jack for brain wave inputs, (Neuromore) these inputs become instructions for the game. (1 hour)

F. **Problems/Issues**

2) Complete isolation from brain wave noise has not been finalized. Our brains just have a lot of things going on at once without a high level of focus. Walid is working directly with the headset to eliminate brain wave frequencies that are not necessary to produce game instructions using tensorFlow. The project schedule will likely run smoothly until we get to the trial phase of using the headset on an average user.

G. **Next Week's Planned Work**

4) Walid will work on finalization of brain wave input processing, to eliminate noise, may require additional assistance from provided OpenBCI software Neuromore.
5) Jack and Brandon will do additional research and development in Neuromore to establish what additional resources will be needed, if any.
6) Brandon will continue development on Pac-Man.

H. Time Log

Brandon- 7 hours

Walid- 4 hours

Jack- 3 hours

WEEK 1 (JAN 31- FEB 7)

A. Weekly Accomplishments

Describe what task was completed and by whom. In parenthesis, provide the number of hours the team member worked on the specific task.

1) GANTT chart completed by Brandon which serves as a framework for our project steps. (2 hours)
2) Initial Maintenance done by Brandon, on OpenBCI headset to perform first testing, was successful in detecting brain waves through connected software. (2 hours)
3) Preliminary literature review completed by Walid, this helps to direct our processes when we begin implementing code. (2.5 hours)
4) Researching and analyzing documentation of OpenBCI and drone hardware by Walid to develop project steps and goals. (3 hours)
5) Summary sheet completed by Jack to ensure a clear goal is established for the project and to help outside observers understand the scope and size. (.5 hours)
6) Proposal presentation completed by Jack to describe the project and planning for it to other students and Dr. Dimitglou. This enabled us to receive feedback and criticism before delving too far into the project. (.5 hours)

B. Problems/Issues

Describe the problem/issue, who is working on it, what is the cause, what has been tried to solve it, expected resolution. Explanation on how it affects project schedule.

1) A project shift from controlling a drone with the headset to controlling a self-developed video game with the headset. The entirety of the group worked on discussing how to adjust for this change, the cause was that any drone with the appropriate capabilities, (full access to drone flight commands via software) would be prohibitively expensive and/or time consuming to work around. We expect that this should not affect project schedule too much even though time was lost trying to decide on how to proceed, overall a video game implementation will save time compared to the drone.

2) The OpenBCI headset had corroded nodes and had to be calibrated, since it was in storage for an extended period of time. Brandon solved this issue and it did not affect the project schedule greatly.

C. Next week's planned work

What do you plan to work on next week? If you have pending issues from section B, how will they affect next week's plan?

1) Jack and Walid will begin development on the game, so that initial testing can begin with the headset after basic controls are implemented. Jack will be creating a graphical interface so the user can manipulate a player character and Walid will be developing controls for this character that will work without the use of the headset.
2) Brandon will be working on identifying brain wave output that could be parsed into video game controls, finding specific wavelengths for left, down, up, right, etc.
3) Pending issues should not affect next week's work, only a shift in planning.

D. Time log

Total Number of Hours worked on the project this week per team member

Brandon- 7 hours

Walid- 12 hours

Jack- 2 hours