University of Manitoba

POST-MORTEN

ECE 3760

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1. **What went well in the project?**
    - The team communication and organization of tasks went smoothly. As a team, we were able to contribute to all the groups assignments and project overall.
    - The design objectives and goals decided were mostly met:
        - Real-time control over the game because of single input with precise and intuitive joystick mappings for direction and intensity.
        - Multiple easy to recognize patterns for different commands making it accessible for both deaf curlers and color-blind curlers and more intuitive minimizing time wasted by the curler in sending or deciphering messages.
        - Able to display messages within the field of view of the sweepers to allow the sweeper to retain focus.
        - The design connectivity covers the whole rink (150ft. or more).
        - Battery life lasts at least the length of a game (up to 3 hours).
    - The software part: skip and sweeper communication using esp-now was programmed successfully:
        - Protocol to send different commands using precise and intuitive mappings.
        - Different and intuitive patterns for LED Ring, acknowledgements for idle and deep sleep mode.
        - Only send message from the skip when there is a change in the command.
        - Callback methods were implemented instead of polling.

- Interface the power switch – hold for 5 seconds will make it enter deep sleep mode.
- Implemented some power saving modes:
  - Limited Transmissions: Only transmit on a command change, Transmission Power: Just enough to cover the playground, Reduced Clock Frequency: We used less than 60% of the max CPU speed and Turn on/off Button: Deep sleep mode entered for periods of inactivity or using the power button.
- Independent light patterns to accommodate colourblind users.

- The physical prototype:
  - Ergonomic, Portable, and modular devices that were intuitive and easy to use. Both the devices had a 3D print that was able to fit all the components and be presented as a working prototype.
- The presentation and poster were well documented and prepared.

2. **What did not go well?**

- Had too many changes from the initial design to the final- maybe for the good or bad but comparatively had less time to spent on the final deign solution.
- Software part:
  - Reduce power consumption and maximize energy efficiency:
    - De-initializing ESP-Now when light sleeping which happens when there is no input from the skip.
    - When there is no command to be send from skip to sweeper, the skip must go to light sleep mode.

    - Implementing Duty Cycling
        - Could not implement the cases when your receiving device misses a packet because it is out-of-sync with the transmitter.
    - Maybe using TCP instead of ESP-NOW.
- Physical Prototype:
    - The 3D design models were not the best fit according to the dimensions, had no frame or inner layering for the components.
        - The 3D prints didn't consider the power button size exactly and the gap between the joystick and power button.
- Marketing Plan:
    - The team bundle should have been a combination of 1skip and 3sweepers.

3. **What would you do differently if you had to do it again?**
    - Initially only think from the user perspective and brainstorm an idea that solves the solution but also reduces complexity and is more intuitive.
    - Implement duty cycling:
        - technique that can be used to conserve power in battery-powered devices, with ESP-NOW, it can enable efficient and reliable communication between two or more ESP boards.
    - Implement power saving modes:
        - In addition to the deep sloped modes for power button, also implement light sleep when the skip has no command to send and de-initializing ESP-Now when light sleeping.

  - Use a software to track power consumed before finalizing the software code.
- Design a 3D model with all dimensions of the joystick, power button for skip and LED Ring, power button and the broom mount exactly taken, have frame/ inner layer for components for the components like Esp-32, battery, joystick, and button boards.
  - skip device to have a more compact design. Also, improve clamp design that allows for a more secure and stable attachment to the broom handle, and easier internal Access.
- Implement vibrational feedback:
  - Implement vibrational direction giving watch for communication of instruction.
- Try an initial idea inspired from Systems Engineering course which was never tried after finding the ease of Esp-Now:
  - Implement a TCP Server (Skip) and 3 TCP Clients (Sweepers).
  - The server would take skip inputs, convert into position mappings single command, and send to the specific client, the client will decode and display the message. This would also be implementing retransmissions, sending acks and taking care of out of order packets.

4. **Useful resources on the line:**
   - Um learn lectures noted were very useful throughout the course both for assignment and design process.
     - Guest lectures
     - Labs

Some useful links that I used to understand curling, ESP-Now or protocol, implementing duty cycling and tutorial for fusion 360 or tinker card for physical prototype.

- https://worldcurling.org/about/curling/
- https://www.cbc.ca/news/canada/nova-scotia/curling-deaf-player-scotties-nova-scotia-1.5460945
- ARDUINO IDE libraries for esp32, esp-now and other basic libraires
    - Master and basic slave, Debounce, Deep sleep modes, Timer Interrupts, GPIO Interrupts.
- ESP NOW https://randomnerdtutorials.com/esp-now-esp32-arduino-ide/
- ESP NOW https://randomnerdtutorials.com/esp-now-two-way-communication-esp32/
- https://randomnerdtutorials.com/esp32-pwm-arduino-ide/
- Beginners' tutorial for Fusion 360 - https://www.youtube.com/watch?v=qvrHuaHhqHI

5. **What were your key takeaways or learnings from this process?**
    - PLAN Early, START Early, IMPLEMENT Early, and FAIL Early.
        - One of the biggest takeaways was to have the physical prototype printed early, test it with the initial code and realize that print need to be perfect according to the dimensions, gaps and have inner frames for components.
    - Learn about the sport curling and the problems for deaf curlers, soldering, design principles, marketing engineering product, filing a patent application and 3D models (physical prototype and 3D printing).
6. **What are you proud of in this process?**

- Working successfully as a team with minimal conflicts and easy resolutions.
- Having implement the skip and server communication easily using esp now which was completely new in the beginning (little bit proud).
- Having a working prototype which met almost all our initial design objectives.
- Having a good presentation.

7. **Who deserves a shout-out (e.g., in your team) for their contributions (perhaps creativity, ingenuity, good ol' hard work, enthusiasm, etc.)?**
   - Everyone in the team had a good amount of contribution and worked hard (have had more than 12 hours of work sessions). So, I feel the whole team was very supportive and friendly. But personally, A special shout to Antony Zaky for being super friendly alongside helping, making everyone improve their skills and transferring some hand on experience.
8. **What else sticks with you about the project and the process?**
   - Working with the team: Team meetings, fun banters, conflicts, and brainstorming sessions. Helping each other learn
   - Learning soldering, design principles and 3D models (physical prototype and 3D printing).
   - The working prototype of the design solution
     - Being the engineering design project where we did everything from coding, designing, planning, marketing, patent application and presentation.