ECE 120 Honors Lab Final Project

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Introduction

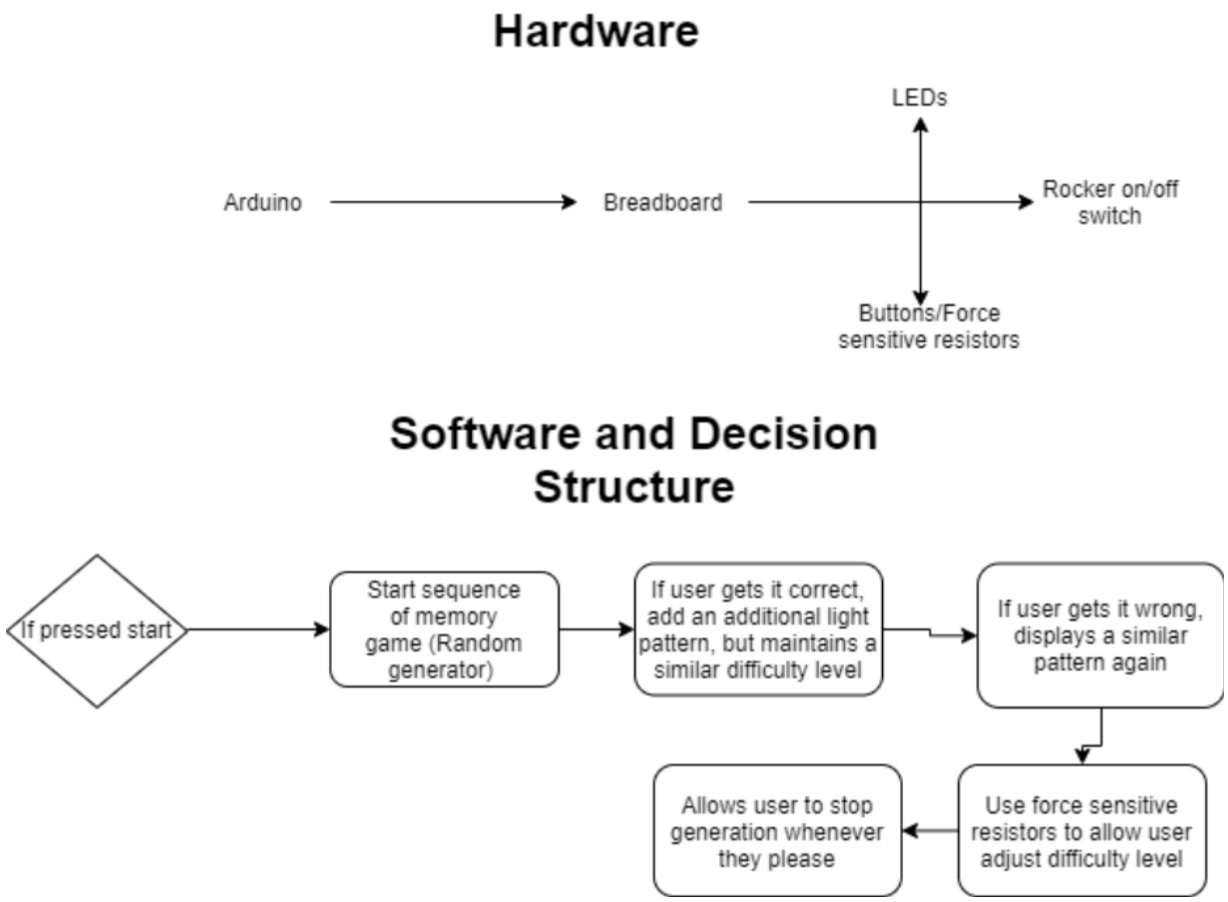
Necessity drives innovation. The need for new technologies has always been pertinent in society. Our project is designed with the objective of addressing one area of need in elderly and hospitalized communities in America as well as low-income families. Sequential memory games, visual processing games, and simple motor development games have long been used at hospitals, rehabilitation, and elderly care centers as a fun way to help brains stay sharp. For our project, we will be creating a portable and affordable alternative to expensive memory training games and devices that can be used for recreation or rehabilitation purposes. We have decided to use Arduinos, LEDs, and buttons to create a game that flashes a series of lights that the player has to match using the buttons that correspond to each light in the correct order. Features of the game include visual cognition (flashing lights), randomization of the order of the lights and color matching (different colored lights). Benefits of these features combined commonly appear in cognitive therapies at hospitals that use neural plasticity in brains to retrain these skills. "Attention, memory, and executive functions are interdependent, and impairments in these areas profoundly impact daily functioning," as stated by the Weill Cornell Brain and Spine center, "Therefore, exercises that increase capacity for attention, working memory, and short-term memory will increase overall mental capacity. Such exercises also increase an individual's awareness of the mental effort required to process information." The game will also provide the option for players to increase or decrease the difficulty level of the game.

Our goal is to develop a working model of our game (Blinky) that can be used to improve visual processing and sequential memory skills as well as simple motor development skills. This is one area in which our game is unique since most affordable memory games are software only, including those commonly used by hospitals/hospices. The manual feature of our game (the player having to push the buttons) provides benefits in motor development for those with impaired brain function such as people who have had extensive surgery, a heart attack, or accident. Motor development also declines with age and develops during the early years of childhood. Therefore, training of any kind which includes cognition and precise physical movements is greatly beneficial for the development of children and hospitalized individuals as well maintaining abilities well into old age.

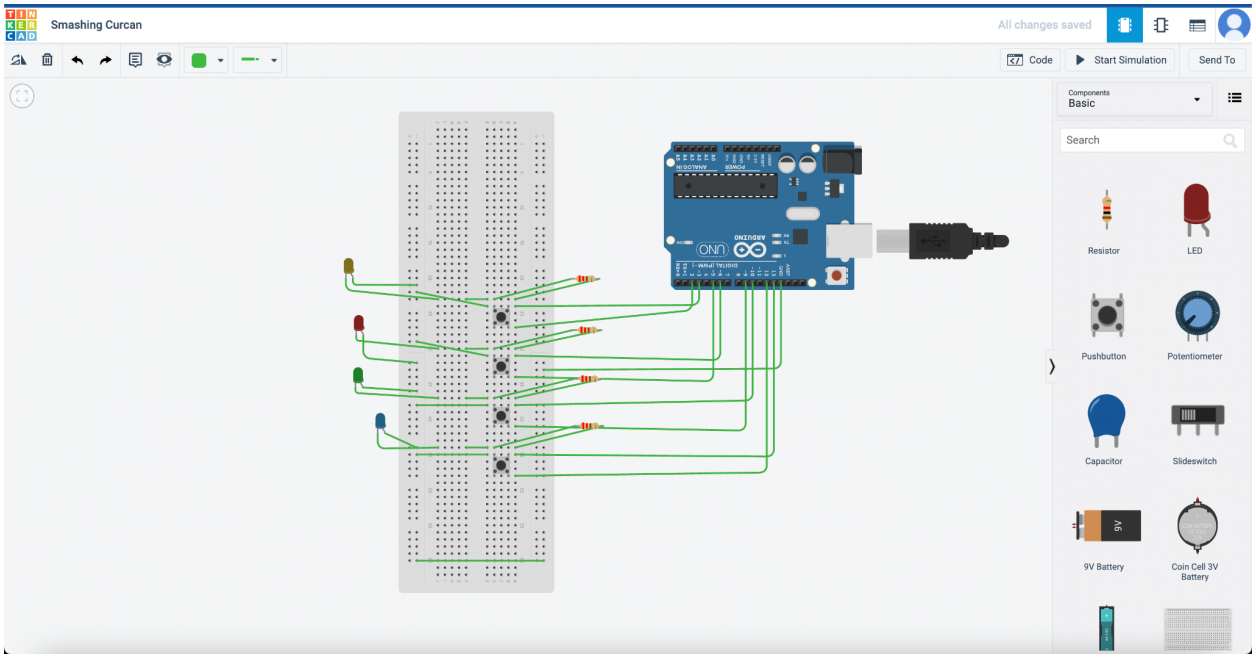
Our project is also useful because it can be used as a fun game that we plan to donate to underprivileged communities where families and local groups may not be able to purchase toys for the community. Since the total cost of the game is about $30 it is also an inexpensive option for the hospitals we will be donating it to, who may have to pay much more for other memory

development tools. Our game can also be helpful for people with reading difficulties, as “poor readers have poor sequential memory,” particularly visual sequential memory which is “the ability to remember things seen in sequence” according to an article published on Edublox Online Tutor.

Design: System Overview and Details



Link to flowchart:
https://drive.google.com/file/d/1SsmQeYsoeZJLz10BhErycsWJTiI1fkwT/view?usp=sharing



The flow chart above provides a simple block diagram of both our hardware and our software, while the TinkerCad image displays the approximate circuit we had. There are some aspects that are different from the circuit displayed on Tinkercad versus the circuit we have built. One of the big differences is that the layout of the pins on the breadboard is different from the ones we were using to construct the circuit. Another difference is that we were able to minimize the number of resistors we had to use to only 1 as we plugged in a resistor from the power to a row on the breadboard where we got all of the power from. Doing it this way allowed us to not only optimize the circuit but also make debugging it much easier. The resistor is connected from the power to a row on the breadboard while the power wire from the Arduino is connected to a pin on the same row as the resistor. This allows us to have a lower flow of electric current throughout a side of the power strip on the breadboard. This makes it easier to connect the positive ends of the LEDs directly to power as the power is at a lower electric current. We then connected one side of the buttons to the inputs on the Arduino while connected the other side of the pushbuttons to the ground portion of the breadboard. Finally, we connected the negative side of the LEDs into the Arduino as well to create outputs for the code to run through.

Results

Originally the project design was meant to use sensors and large buttons to ensure and implement the dexterity aspect of the game for the elderly audience, but by committing to further research, we realized that sensors wouldn't contribute to the dexterity aspect of the game as much as buttons for which we used small buttons on the breadboard. In our future design, when we connect this to a high fidelity game board prototype, we also plan on upgrading to the big push buttons that we purchased in order to allow for more accessibility for all groups of people that would like to make use of our game. Our primary focus for this project was for the game to

work as a visual and memory processing aid which mainly relied on randomization and remembering patterns. In our design, we have the LEDs run a random sequence of patterns that the user then has to try to remember and input it in with the help of the buttons which is the core of the characterization of the buttons. In the future, we also hope to improve the randomization process along with providing a score generator.

Problems and Challenges

During the course of the project, we were faced with many problems and challenges and as engineers, we were faced with the tough responsibility of solving them ourselves. The first major challenge that we had was creating the basic breadboard layout that can work for the memory game. We were able to create a basic breadboard layout during the first couple of weeks into the project, however, it was not fully optimized and had too many redundant and unnecessary wires. This became difficult to debug the circuit and it resulted in further problems as some wires lost their connections to the Arduino. However, we were able to fully optimize the circuit design as best as we could by using online circuitry software such as TinkerCad.

Another problem we faced was with the Arduino code we were trying to write. This was because both of us had very limited experience with the Arduino language so we had to learn the basics from scratch. Even though we were able to get the foundation of the program, the implementation of the circuit was a little difficult as we were encountering multiple compiling errors. On top of that, the code that we kept on running had some difficulty properly running the circuit so our expected output was very different from what we were trying to achieve.

Future Plans

Our future plans include improvement and revisions to the game design. We are passionate and committed to our idea and hope to improve it in the future according to the needs of people. We hope to tailor it to an individual's needs. We will continue to stay receptive to feedback and make any changes necessary or take into account any suggestions. Our own plans for improvement include a better randomization process, an upgrade from a low fidelity to high fidelity game board -- a design where people don't have to play it on an actual breadboard but rather something that appears to be more comfortable, sophisticated, and accessible. We also have to bring about a score generator for those who would like to keep track of their progress. Apart from this, we would also like to allow people to change difficulty levels. After all these changes, we also hope to add a display screen to display messages regarding scores and their progress and really nice, encouraging messages to keep people going and stay motivated. We have had the opportunity to test and receive feedback of our progressing design from elderly groups and children and we received good comments. Everyone interviewed mentioned how it helped them spend time exercising their memory processes and movement. Now that we see the potential our game has and how much of an impact it can actually make, we are more excited than ever to continue improving this project!

References and Appendix

Edubloxtutor.com. 2021. *Sequential Memory: Definition, Importance, Overcoming Deficits - Edublox Online Tutor*. [online] Available at: <https://www.edubloxtutor.com/sequential-memory/> [Accessed 19 September 2021].

Weill Cornell Brain and Spine Center. 2021. *Cognitive Remediation After a Stroke*. [online] Available at: <https://weillcornellbrainandspine.org/condition/stroke/cognitive-remediation-after-stroke> [Accessed 19 September 2021].

Note: Link to code on wiki page