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Different Brain-Computer-Interface Numeric Keyboard Designs

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Abstract: This article presents projects of different Brain-Computer-Interface (BCI) numeric keyboard interfaces that were created in the Unity Engine.

Keywords: brain-computer Interface, neural, brain activity

1. INTRODUCTION

This paper delves into the development of different types of Brain-Computer-Interface (BCI) numeric keyboard interfaces designed for entering numbers, all crafted within the Unity engine. Electroencephalography (EEG) is a non-invasive method used to monitor brain activity by detecting voltage fluctuations that arise predominantly from the synchronous activity of neurons in the brain. These fluctuations are typically observed within a frequency range of 1 to 30 Hz. [1]. Various effects stemming from brain activity, including slow cortical potentials (SCP), stimulus-induced synchronization and desynchronization, steady-state evoked potentials (SSEP), and the P300 wave, can be harnessed to effectively regulate diverse processes [2, 3].

In this study, the employment of electroencephalography (EEG) capitalizes particularly on steady-state evoked potentials (SSEP), with a specific focus on steady-state visual evoked potentials

(SSVEP). These potentials, elicited by stimuli of specific frequencies, exhibit rapid response times, rendering them invaluable for BCI applications. This technology holds significant promise, especially in aiding individuals with disabilities for rehabilitation and communication purposes.

2. DESIGNS

The Designs were created in the Unity Engine, seven different designs were created, with the limitation of 10 numbers per numeric keyboard, so the designs tried to utilize the designs capabilities to it's limits. The buttons work through SSVEP [4], they have assigned a different type of NextMind active asset, the assets work because of different patterns and blinking frequencies. Looking at a specific button creates a specific signal in brain that the EEG can read. That allows to determine which button is chosen by the user.

2.1 First design

It's a standard number keyboard design, but it lacks a "0", which makes the count of number combinations smaller. It's possible to implement a way to write zeros, for example if pressing "enter" would pass to the next number and zero is the default.

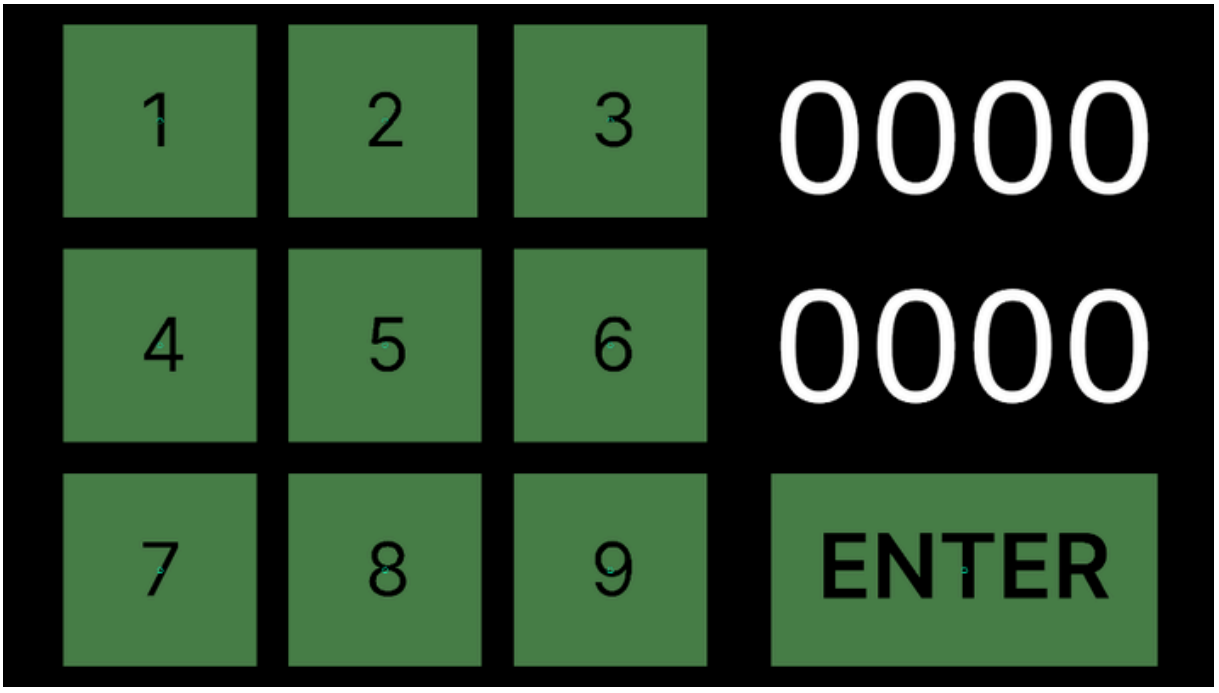


Figure 1. First Design of a BCI numerical keyboard

2.2 Second design

Second design allows to write much more precise and complex, but there is a possibility of it being slower than other designs, however it allows to implement in the future more buttons, because in none of the menus the limit of ten buttons is used. This design has one main menu [Fig. 2] and several sub menus [Fig. 3-4].

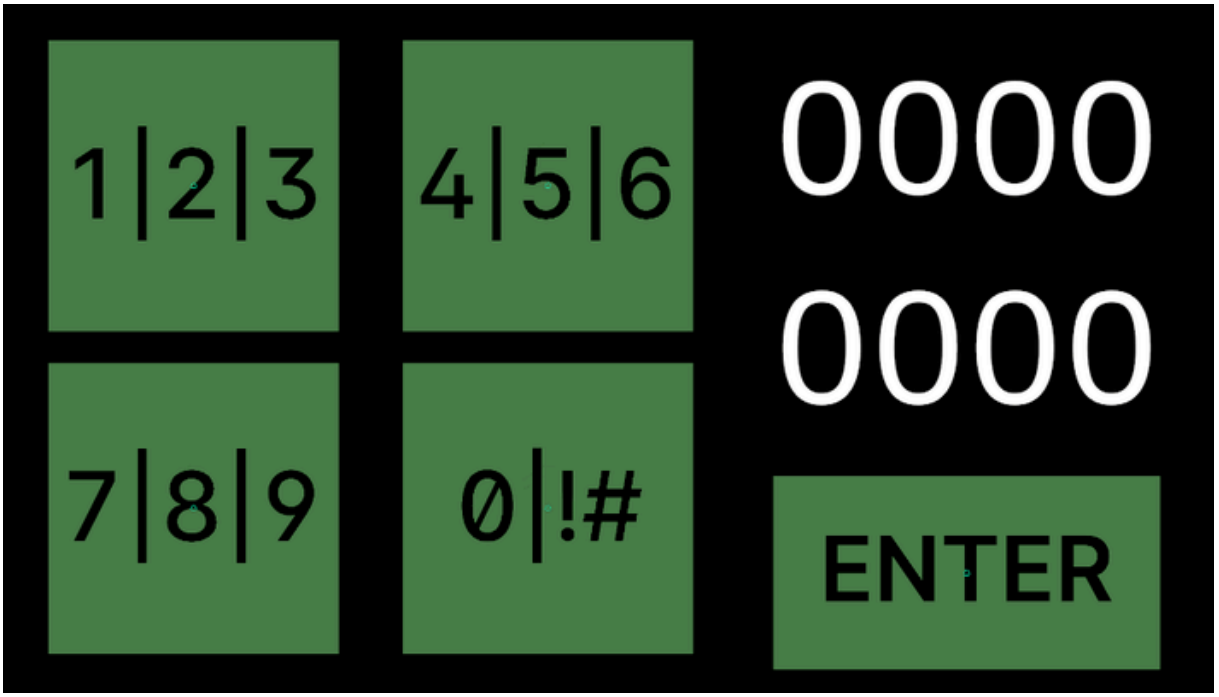


Figure 2. Second Design of a BCI numerical keyboard, in the main menu

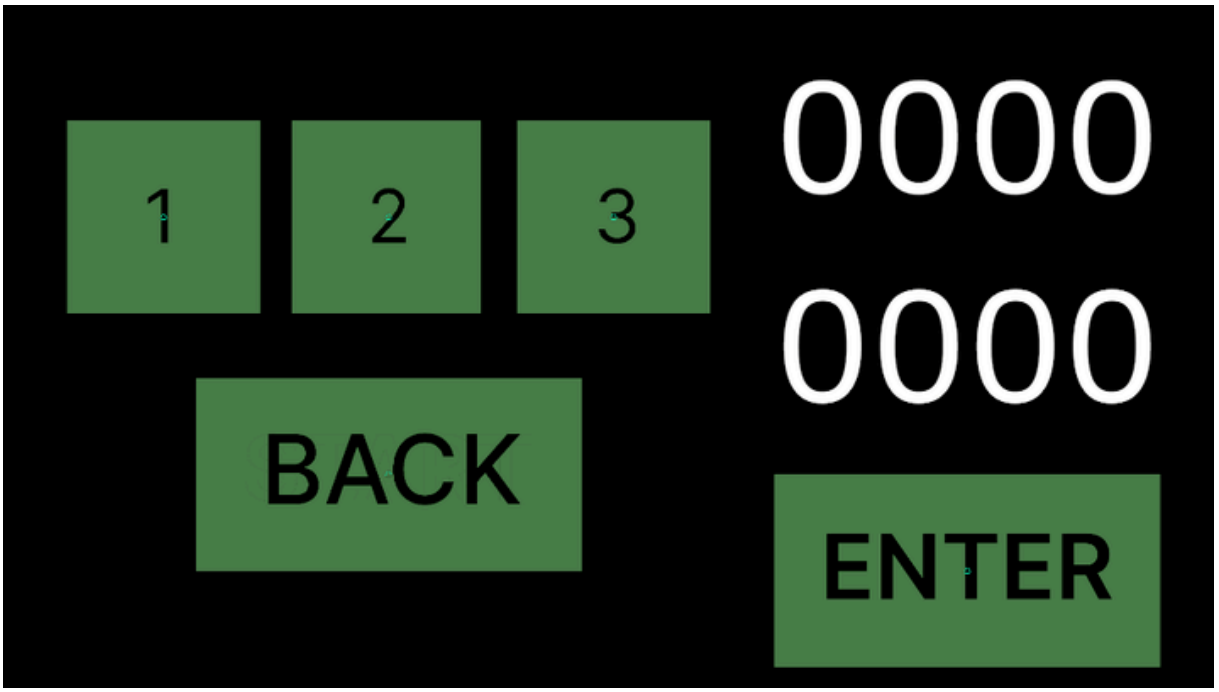


Figure 3. Second Design of a BCI numerical keyboard, in the first menu

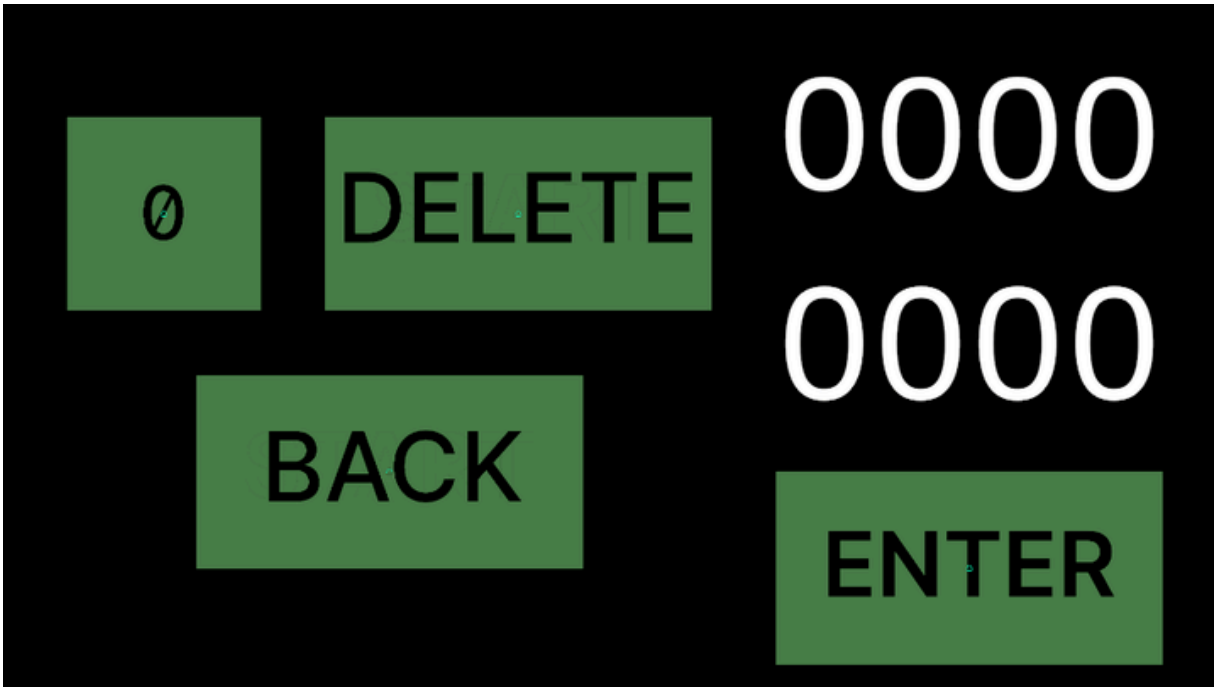


Figure 4. Second Design of a BCI numerical keyboard, in the last menu

2.3 Third design

The Third design is a blend between the first two, it uses similar menus as the Second Design, but it also has a typical layout that people are used to. It lacks the possibilities of the Second Design, but people used to a layout can be an advantage during tests.

Figure 5. Third Design of a BCI numerical keyboard, with the first menu open

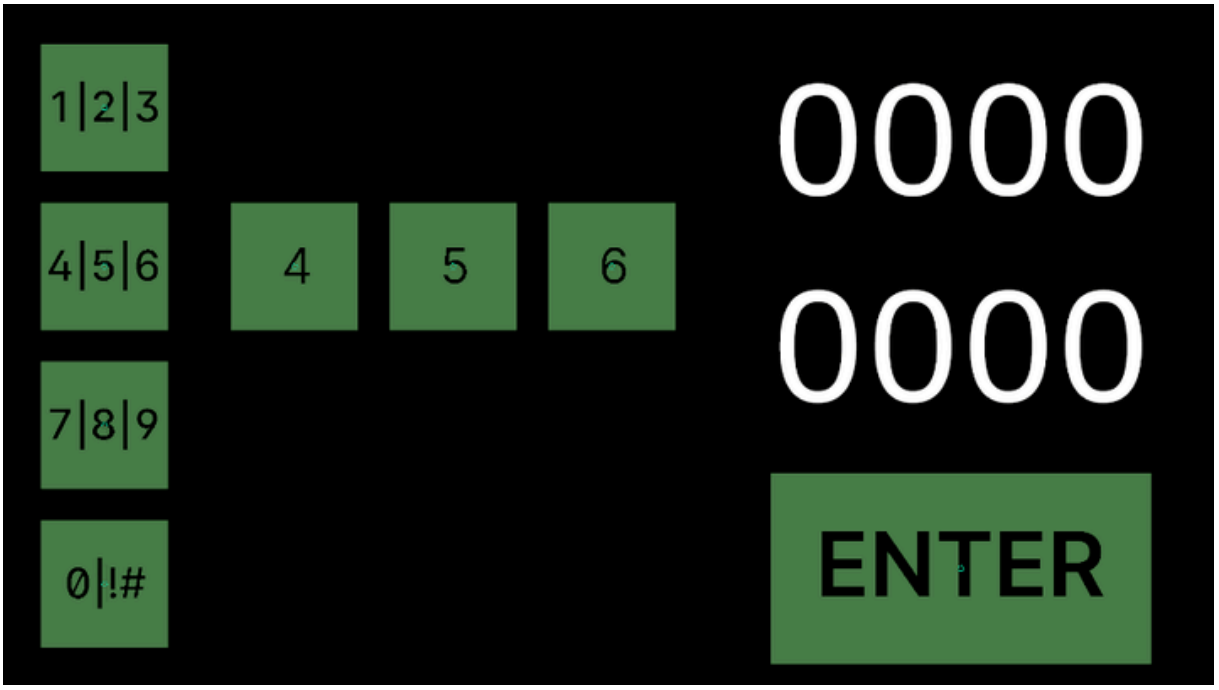


Figure 6. Third Design of a BCI numerical keyboard, with the second menu open

2.4 Fourth design

The Fourth Design is a simplified version of the Second, with only two menus. It has a simpler design, it still allows for some future improvement, but it is less flexible. It has a main menu [Fig.7] and two sub menus [Fig. 8]

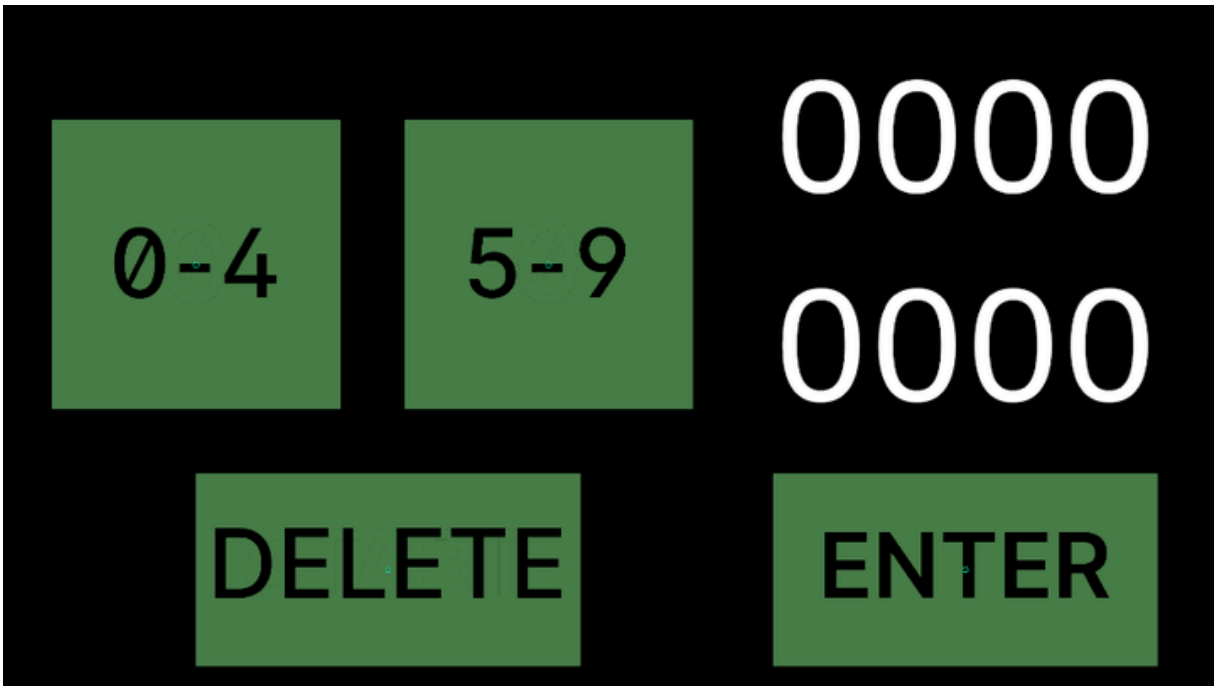


Figure 7. Fourth Design of a BCI numerical keyboard, with the main menu open

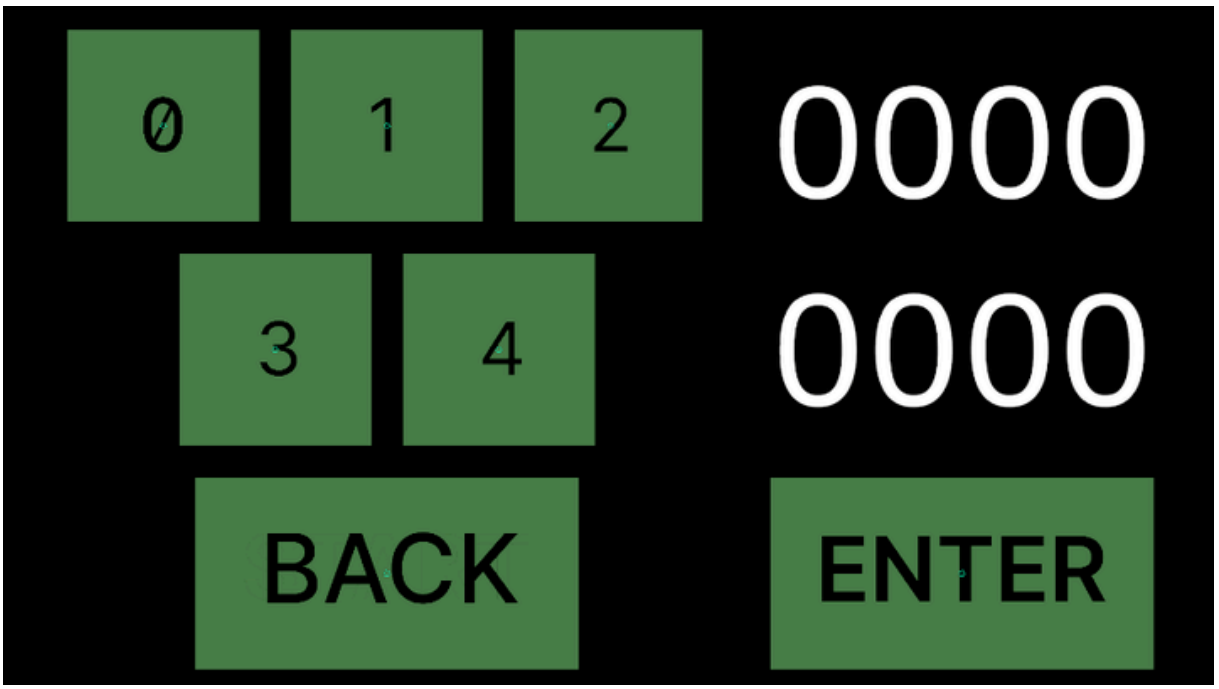


Figure 8. Fourth Design of a BCI numerical keyboard, with the first sub menu open

2.5 Fifth design

The Fifth Design is based on the First one, but with a zeros instead of an enter, which provides another problem with the number selection, because every number and be selected only once.

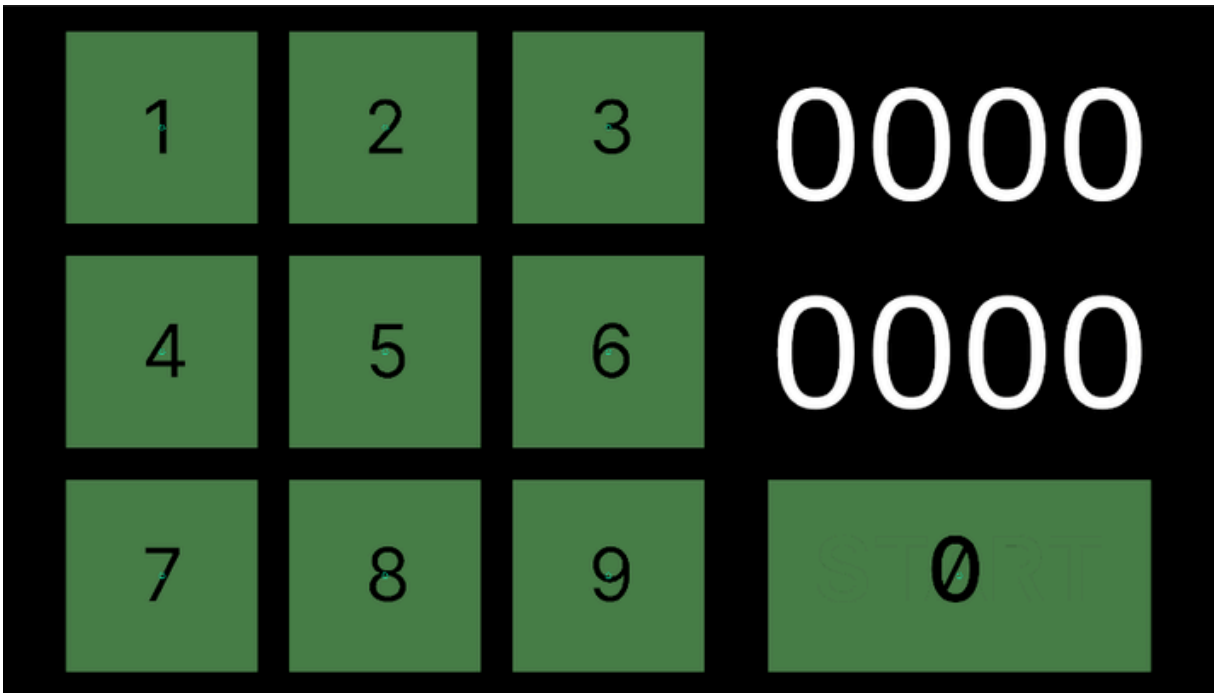
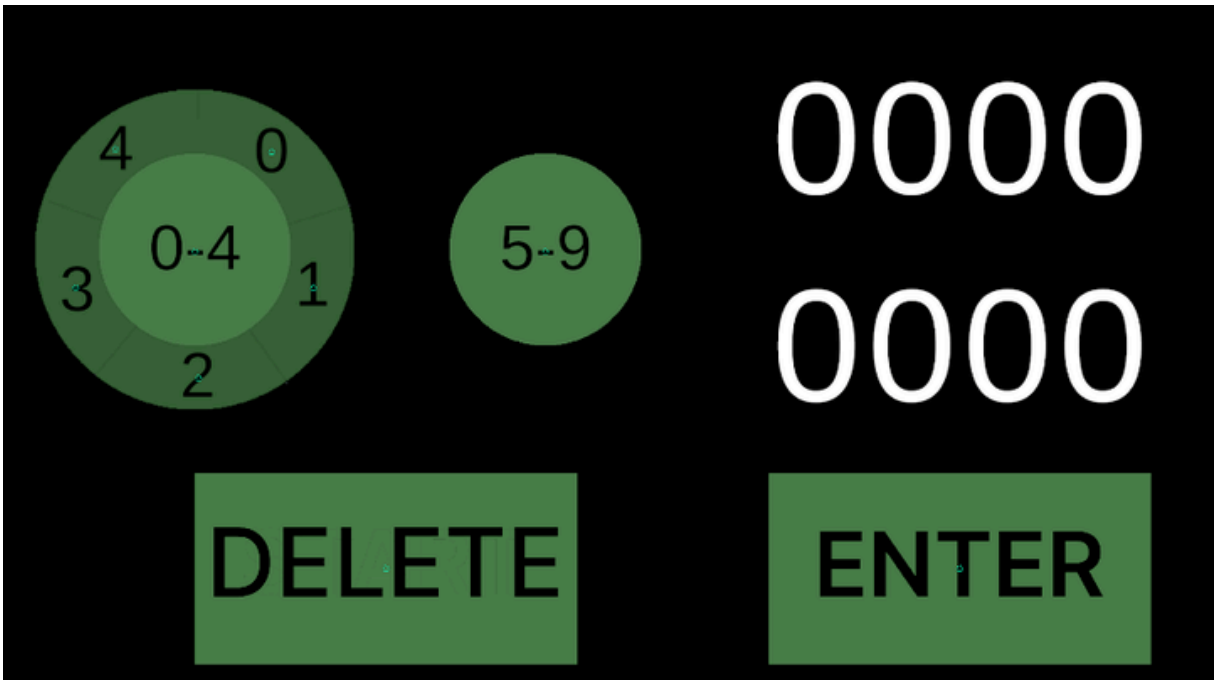


Figure 9. Fifth Design of a BCI numerical keyboard

2.6 Sixth design

The Sixth Design is a different version of the Fourth, with two menus in a circle. It's a more intuitive design, but allows for even less flexibility with additional buttons. It's reaching the 10 buttons



limit.

Figure 10. Sixth Design of a BCI numerical keyboard, with the first part expended

Figure 11. Sixth Design of a BCI numerical keyboard, with the second part expended

2.7 Seventh design

The Seventh Design is similar to the Fifth Design, it has a different layout, that could be more effective and intuitive.

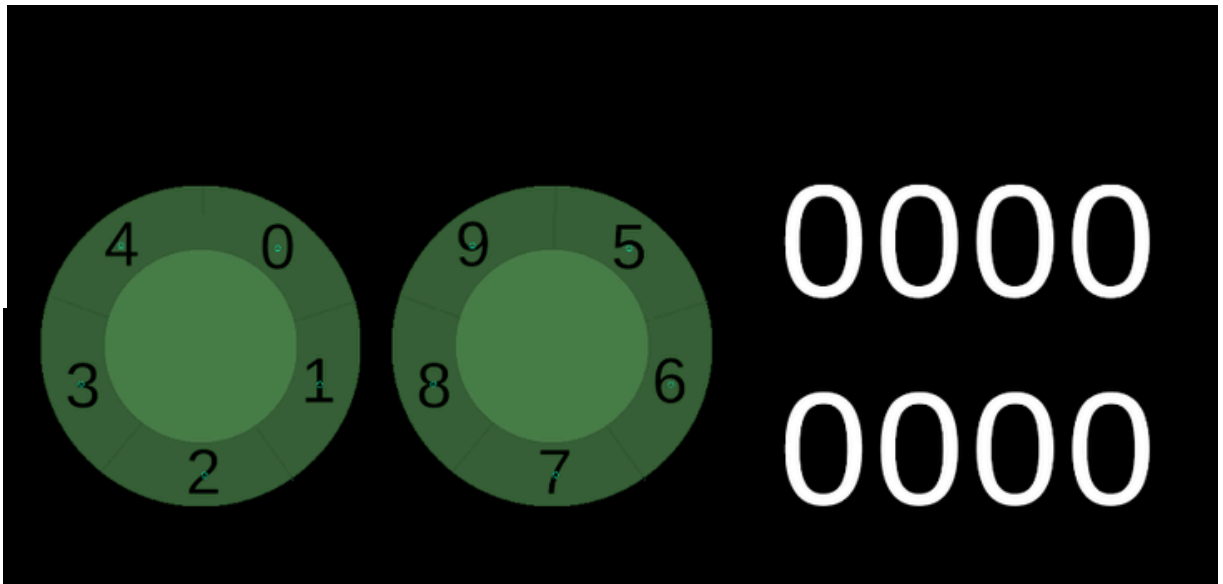


Figure 12. Seventh Design of a BCI numerical keyboard

3. FUTURE FURTHER DEVELOPMENTS

The next step of development is to test all of the designs and choose the best ones to develop them further. Few of possible further developments include extending the BCI to include more combinations and buttons, that's especially likely, if the keyboards based on menus and submenus prove effective. Another way of development is a more personalized interface, customizable by the user, that would allow for the best effectiveness, but would require better calibration and would be less objective in tests.

4. CONCLUSION

Various designs of Brain-Computer-Interface (BCI) numeric keyboard interfaces were developed within the Unity Engine, leveraging electroencephalography (EEG) technology, particularly steady-state evoked potentials (SSEP). Each design offers unique features and trade-offs, ranging from simplicity to flexibility. The future of this technology lies in rigorous testing to identify the most effective designs for further refinement. These developments hold promise for improving accessibility and communication for individuals with disabilities, marking a significant step forward in BCI technology.

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