Enhancing Esports Performance

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Augmenting Human Dexterity – Spring 2023

Term Project: Report and Research Proposal

Abstract

This study presents the development and evaluation of an ergonomic wrist-supporting device designed to alleviate wrist strain and improve gaming performance in first-person shooter (FPS) games. The device consists of a sleeve, a low-friction pad and a boning attachment, which together reduce friction and maintain the user's wrist in a more neutral position. The effectiveness of the device was assessed through three tests: a friction reduction test, a game performance test, and a comprehensive ecological observation during actual gameplay. Results demonstrated that the device successfully reduced friction by 30% on average, and decreased aiming reaction time by 40ms. Additionally, the ecological observation showed an overall improvement in wrist posture and movement patterns. This work contributes to the understanding of ergonomics in gaming and has the potential to positively impact individuals experiencing wrist strain during extended gaming sessions. Furthermore, this study encourages a more health-conscious approach to technology design and development, extending its implications beyond gaming to other computer peripherals and everyday computer usage.

I. Introduction

Esports, or competitive video gaming, has exploded in popularity in recent years, with millions of fans tuning in to watch skilled players compete for high stakes. Esports tournaments now offer prize pools that rival those of traditional sports, and top players can earn millions of dollars in winnings and sponsorships. With so much on the line, it's no surprise that esports players are constantly seeking ways to enhance their performance and gain a competitive edge. They continue to engage in repetitive and sustained loading, which potentially increases their risk of developing injuries, such as sustained wrist extension angle and hand muscle contraction [1]. This is also supported by a survey where eSport athletes reported wrist pain (36%) and hand pain (32%)[2]. Therefore, due to the mental and physical demands of prolonged training, combined with the intense competition in some esports leagues, most professional gamers retire before reaching the age of 30[3].

Besides professional athletes, the public is also influenced by gaming injuries. According to a 2022 report by the Entertainment Software Association, there are 215.5 million active video game players across all ages in the U.S. [4]. Another report stated that the average amount of time spent playing with others online was 6.5 hours per week in 2015, which has been linked to potential injuries such as hand and arm pain, as well as muscle stiffness [5].

In this report, we will focus specifically on a device designed to enhance upper-body performance. While esports is often associated with mental acuity and quick reflexes, physical fitness and dexterity can also play a crucial role in performance, particularly for games that require precise mouse and keyboard movements or controller inputs. Moreover, as the risk of gaming-related injuries is a serious concern, our device is designed to reduce the likelihood of such injuries and discomfort associated with prolonged gaming sessions. By providing support and training for hand movements, our device aims to help esports players relieve stress and improve their performance.

This report will examine the design and functionality of our device, as well as its potential benefits for esports players in terms of reducing the risk of injury and enhancing performance.

A. Background

In recent years, people have become more concerned about the health and performance of esports players. For example, ANSI/HFES 100-2007 [6] provides ergonomic guidelines for armrests, wrist supports,

and forearm supports including the proper positioning of armrests and the need for adjustable supports for prolonged use.

There has been a significant increase in interest and investment in developing technologies and devices to support and enhance esports performance. Existing technologies in this space include specialized gaming chairs, gaming-specific keyboards and mice, and high-performance monitors with high refresh rates. Additionally, there have been some devices designed to support upper-body performance, such as armrests and wrist supports for better ergonomics, or grip trainers for improved dexterity.

However, there is still significant room for innovation in this area, as there are challenges in designing devices that provide support and training without impeding the player's movements or introducing unnecessary distractions. Additionally, the device must be adaptable to different body types and playing styles, as well as compatible with a variety of games and setups. This is a big challenge, as there is a consensus that gaming mouse selection and purchase should be an individualized process based on individual needs, work demands, usage period, and ergonomic matters [7]. Furthermore, even if some designs become successful products, they may not meet the users' needs. For instance, a study evaluating mouse pads designed to enhance gaming performance showed that the different mouse pad surfaces did not significantly affect performance in terms of movement time or error rate [8].

Therefore, our hypothesis is that a custom-designed device that can enhance upper-body performance without distracting the user could increase competitiveness in gaming. Through our research and development process, we will work with an esports player to inform our design decisions and ensure that our device offers a unique and valuable contribution to the growing world of esports technology and performance enhancement.

B. Overview

In this report, we will explore the development and testing of a device designed to enhance upper-body performance for esports players. In Section II, we will hear from an experienced esports player about their struggles with upper-body strain and their current methods for addressing these issues. Then in Section III, we will present our proposed device and testing methods. In Section IV, we will discuss the original contributions of the proposed device and its potential impact on the esports industry and the broader field of performance enhancement technology. Finally, in Section V, we will explore the potential societal and ethical implications of performance enhancement technology in esports and beyond.

Our objective is such that, by the end of this report, readers will have a comprehensive understanding of the potential benefits and limitations of the specialized device for enhancing upper-body performance in esports, as well as the broader implications of performance enhancement technology in society.

II. Interview case study

We conducted an interview with an experienced esports player to gain insights into their equipment setup, playing habits, injury prevention and recovery habits, stress levels, and other related topics. This interviewee is not knowingly disabled and have more than 2000 hours in computer game experience.

The interview begins with an introduction and obtaining consent, followed by an overview of the player's equipment setup and related habits. The deep dive section includes observing the player during actual game play and exploring their injury prevention and recovery habits, stress levels, and other relevant factors. The reflection section involves interpreting important observations and behavior, receiving feedback from the interviewee, and identifying potential areas for future research and development. Overall, the interview process is a valuable tool for understanding the unique experiences and needs of individual esports players, and can inform the design and development of performance enhancement devices that are tailored to their specific needs.

Based on the interview results, we have identified a list of needs from the interviewee, which is summarized in Table. II in the appendix. The top 5 needs that we have identified are as follows, which will be what our proposed device will focus on addressing:

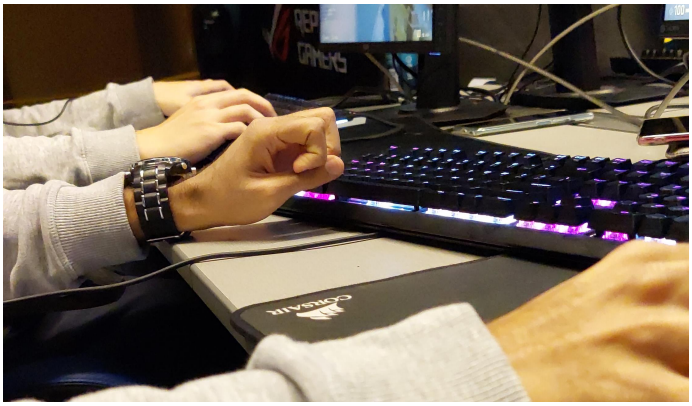

Fig. 1. A photo of interviewee using gaming equipment during the deep-dive, actual game play session.

Need type	Interview statement	Interpreted need
Control features	Mouse pad has inconsistent surface resistance, change in speed is frustrating.	Better mouse consistency.
	I clean plastic pads under mouse once a month. I feel like they give me greater control by ensuring consistency.	Friction should be low and consistent.
Design features	Wiping hands after game pause.	Moisture is generated during game play and needs to be cleared.
Injury prevention	Stretching fingers immediately after game pause.	Alleviating muscles and joint discomfort after intense activity.
	Elbow resting on the chair, wrist is moving most of the time with a large motion range.	Reduce wrist motion range.

TABLE I
TOP 5 USER NEEDS BASED ON INTERVIEW RESULTS

III. PROPOSED DEVICE & TEST METHODS

A. *Proposed Device*

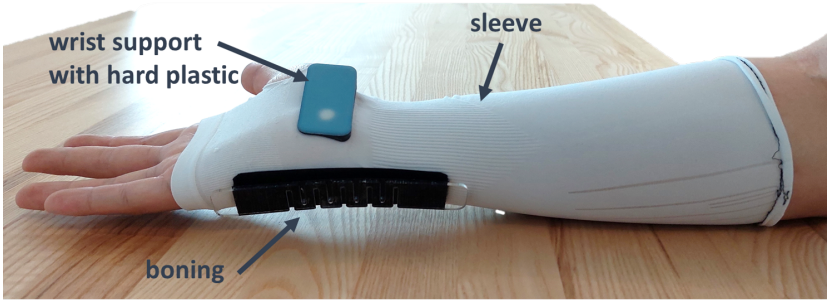

Fig. 2. There are three main features of our device: the sleeve, boning, and the wrist support with a hard plastic pad.

The device is a multi-function wearable intended to address various ergonomic and performance issues. Its chief advantage is that it leverages existing materials and methods, avoiding the need to develop or research any novel technologies. The device is worn as a sleeve that extends up to the metacarpophalangeal joint and down to just before the elbow.

1) Sleeve: The sleeve has one pad affixed to the underside of the structure to reduce friction and disperse concentrated forces resulting from contact with irregular surfaces. Additionally, the sleeve extends underneath the hand in close proximity to the palm, absorbing and routing moisture away from the underside of the hand to be evaporated elsewhere.

2) Boning: The boning structure along the radial side of the hand provides the function of dampening rapid and sudden radial and ulnar deviations. The boning attachment is a laser-cut living hinge style spring, and its stiffness can be easily modified. The boning is attached by Velcro, making it modular and allowing the user to easily change the stiffness.

3) Wrist support with hard pad: The wrist support has two layers. The upper part, a support piece attached to the wrist, is made of a soft rubbery material called TangoBlack Plus. We use a 3D scanner to scan the user's forearm to create the shape of the support attachment, which allows the pressure to be distributed more evenly across the wrist. The lower part, a friction-reduction pad that contacts the mouse pad, is made of a hard plastic called VeroWhite. As a result, the wrist support provides soft cushioning for the wrist while having a low-friction hard pad contact with the table.

B. Test Methods

To evaluate the effectiveness of the proposed device, we performed three separate tests, each looking at a different aspect of the device. The first test evaluated the effectiveness of the device in reducing friction. The second test evaluated how the device and different boning stiffness affect the user's game performance. The third test was a comprehensive ecological observation of the user during actual gameplay with different device configurations to see to what extent the device changed the user's gameplay behavior.

Fig. 3. Friction test setup. The left shows the test with the sleeve on, whereas the right shows the test without the sleeve.

1) Friction Reduction Test: We first analyzed how much our device reduces the friction felt by the user as the mouse is being moved. We conducted the test in two different settings, one with the device on, and one without wearing the device. We asked the user to wrap the mouse on a mouse pad while not actively exerting any force on the wrist. Then, we hooked up the user's thumb to a spring gauge and dragged the hand with the spring gauge at a constant speed to measure the friction force. We repeated the test for each setting five times to ensure consistency.

From the test results 5, we concluded that the device is able to reduce the friction on the wrist by 30% on average. We believe that the reduction in friction alone can increase the user's gaming performance, and this will be validated in the follow-up Game Performance Test.

2) Game Performance Test: To evaluate if the device can improve the game performance, we asked the user to perform a visual target engagement test from https://humanbenchmark.com/tests/aim. Each round, the test presents the user with 30 total targets that move across the screen in different patterns and directions sequentially. The user's goal is to click on the targets as quickly and accurately as possible. The Aim Trainer measures the user's reaction time and displays the average time per target at the end of each round. There is a high correlation between a low time per target and high performance for FPS games, where the player has to shoot the opponents quickly and accurately, or face the risk of getting killed. In contrast to playing actual games and measuring win rate, the visual target engagement test is a much faster way of measuring performance and removes the variations in opponents across different matches.

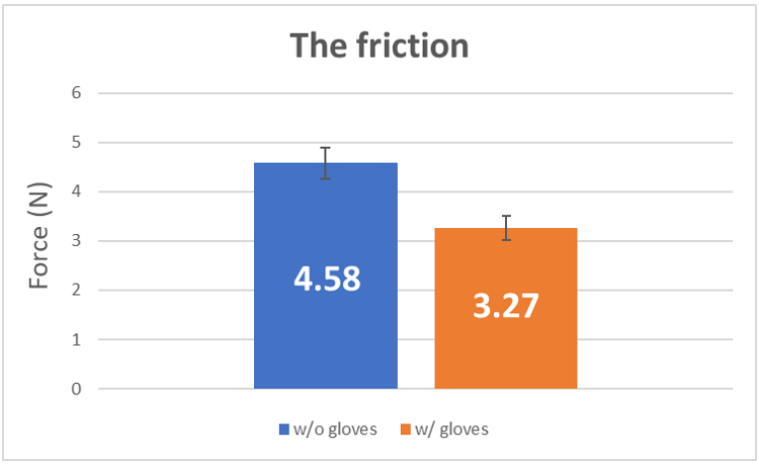

Fig. 4. Friction test result. The sleeve reduces the friction by 30% on average.

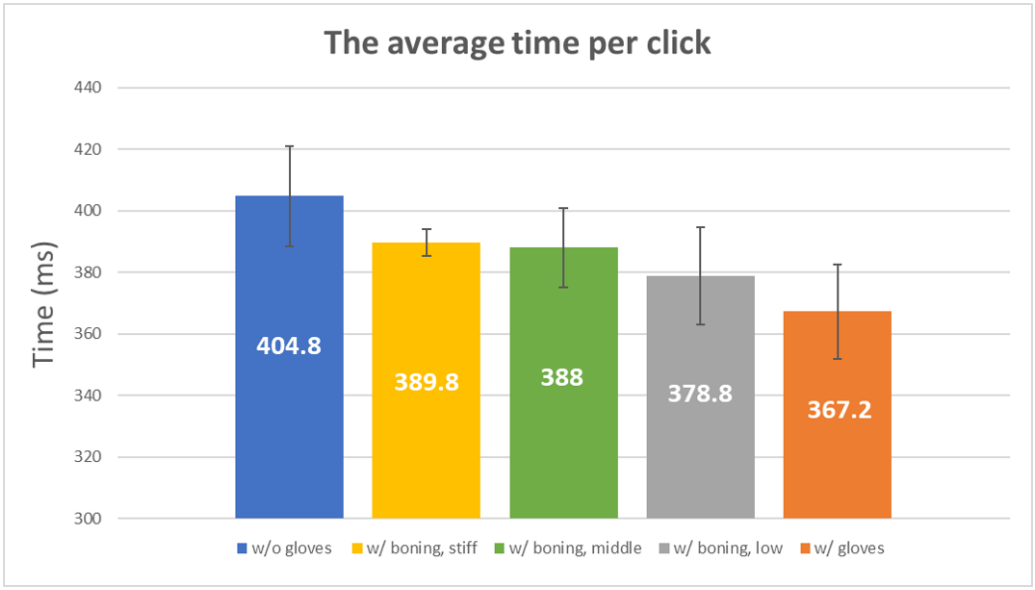

Fig. 5. Average time per target. The sleeve reduces the reaction time. Having a stiffer boning results in a higher reaction time.

We asked the user to perform the test under five different settings, including without the sleeve, with the sleeve and no boning, with the sleeve and soft/low boning, with the sleeve and regular/middle boning, and with the sleeve and hard/stiff boning. The test was repeated five times for each setting, and the average time per target was measured. We found that the sleeve alone is capable of reducing the aiming time by 40ms, which shows that the reduction in friction improves the game performance. However, as the stiffness of the boning attachment increases, the reaction time increases. This makes sense intuitively as a stiffer boning requires a larger force on the wrist, which reduces the force to create hand displacement quickly.

3) Comprehensive Ecological Observation: Lastly, we asked the user to play actual CSGO games in the Cal Esports center for ecological observation. Two competitive games were played, and the sleeve setting was changed during the game to replicate the five different settings mentioned in the previous test. The user played at least 10 minutes with each setting for meaningful observations.

We observed that without the sleeve, the user always anchored the wrist on the mouse pad and initiated almost all motions from the wrist by pivoting (radial and ulnar deviation). The user also ”bunny-hopped” the mouse when sudden motion was needed. The user’s wrist naturally deviated to the ulnar section in

Fig. 6. Without the sleeve, the user's wrist naturally deviated to the ulnar section in the rest position. With the sleeve, the user's hand became straightened with the arm

the rest position, and a large ulnar deviation was often observed. However, with the sleeve on, the user's hand became straightened with the arm. The user no longer anchored the wrist on the mouse pad and instead initiated motions more frequently from the elbow and the shoulder, which is likely the result of lower friction on the wrist. The drastic ulnar deviation was reduced even without attaching any boning, and was reduced even more as stiffer boning was attached. The "bunny-hopping" of the hand was also eliminated and the motion became smoother. However, we did observe that while the fabric was able to absorb the moisture on the palm, it was not able to transport it elsewhere and evaporate it. Thus, further material-related research is required.

IV. Intellectual Merit

The proposed device offers several unique features and advantages compared to existing esports performance-enhancing technologies. The device's innovative design, which combines a sleeve, boning, and a wrist support with a hard pad, aims to provide support and training for hand movements without impeding the player's movements or introducing unnecessary distractions. Additionally, the modular design allows for personalization and potential customization by end-users. By working closely with esports players during the research and development process, we aim to ensure that our device is tailored to the unique needs and preferences of the gaming community. By conducting rigorous tests and analyzing the results, we have gained valuable insights into the effectiveness of our device and its potential impact on the esports industry.

This study acknowledges certain gaps and shortcomings, such as the inability to dissipate moisture effectively. Additionally, the study may not address all ergonomic issues faced by gamers, and further work may be needed to fine-tune the device's design and optimize its performance. Ultimately, the proposed work provides a foundation for future research, innovation, and development in the gaming and ergonomics fields.

V. Broader Impact

This work has the potential to positively impact individuals suffering from wrist strain and discomfort caused by extended gaming sessions. By addressing ergonomic issues and improving gaming performance, the device can enhance the overall gaming experience and mitigate health risks associated with long-term computer usage. We hope to make the invention open-source, enabling others to build upon our design and contribute to the development of even more advanced ergonomic gaming solutions.

Beyond the gaming community, this work could also influence the design of other computer peripherals and promote the importance of ergonomics in everyday computer usage. This study highlights the significance of considering user comfort and health when designing and developing new products. We hope to

encourage a more inclusive and health-conscious approach to technology and inspire future innovations that prioritize user well-being.

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APPENDIX A
ADDITIONAL TABLES

Category	Interview statement	Interpreted need
Mouse	The mouse has 2 more buttons on the side in addition to left and right buttons.	The mouse has at least 2 more control buttons than regular office mice.
	I clean plastic pads under mouse once a month. I feel like they give me greater control by ensuring consistency.	Friction should be low and consistent.
Monitor	A good monitor with high resolution (1440p).	The monitor has fine graphics.
	The monitor should be at least 120 Hz.	The monitor responds fast.
Controller	Does not use controller.	Creating ergonomic solutions here is not necessary.
Main Frustration with Equipment	Mouse pad has inconsistent surface resistance, change in speed is frustrating.	Making small, precise and quick motions is important and interference with that causes physical and emotional stress.
	Mouse pad sometimes does not have enough room.	The mouse is able to cover a large range physically.
	Prefers wired mouse because of low latency, but wire entanglement can be annoying. The wire has to be routed in a certain way to reduce the interference.	Response time is critical. Consistency in the mouse's physical properties regardless of its position and orientation is important.
Microphone	Feels like something is in the face.	Visual range is clear of obstacles.
Discomfort, self-reported and otherwise	The neck and upper back frequently experience aches and pains. The forearms and fingers occasionally. Headaches and eye strain. No other self reported discomfort.	Alleviating upper-body rigidity. Getting arm off of the edge of table. Reducing palm moisture. Reducing finger and arm fatigue.
Non-verbal Observations	Stretching fingers immediately after game pause.	Alleviating muscles and joint discomfort after intense activity.
	Knuckle cracking after game pause.	Relaxing joints.
	Mouse bumping into computer.	Mouse range needs to be extended.
	Elbow resting on the chair, wrist is moving most of the time with a large motion range.	Provide better support, reduce wrist motion range.
	Wiping hands after game pause.	Moisture is generated during game play and needs to be cleared.
	Not doing much upper-body (neck, head) movement.	Upper-body not important? (maybe game time is too short to see any interesting behavior)

TABLE II
FULL USER NEEDS TABLE

APPENDIX B
ADDITIONAL FIGURES

Fig. 7. This first generation arm sleeve prototype provides support for the palm and a smooth surface beneath the arm.

Fig. 8. Sewing together the lycra fabric to be form fitting, comfortable and ready for mounting our hardware.

Fig. 9. Scanning the shape of the forearm to create the shape for the wrist support.

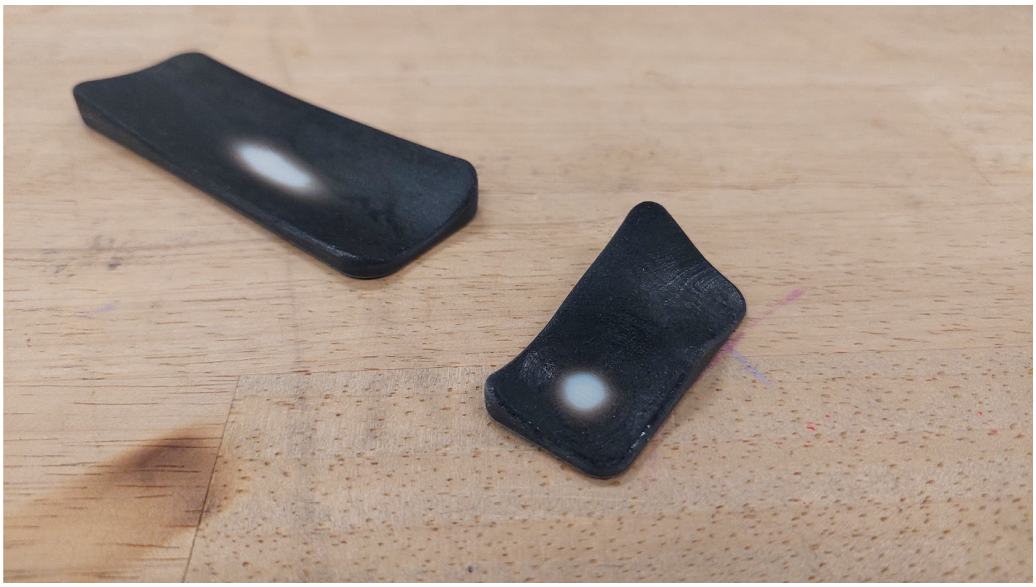

Fig. 10. The wrist and arm supports. The arm support is not used because its higher stiffness than the tissue around human arm creates discomfort.

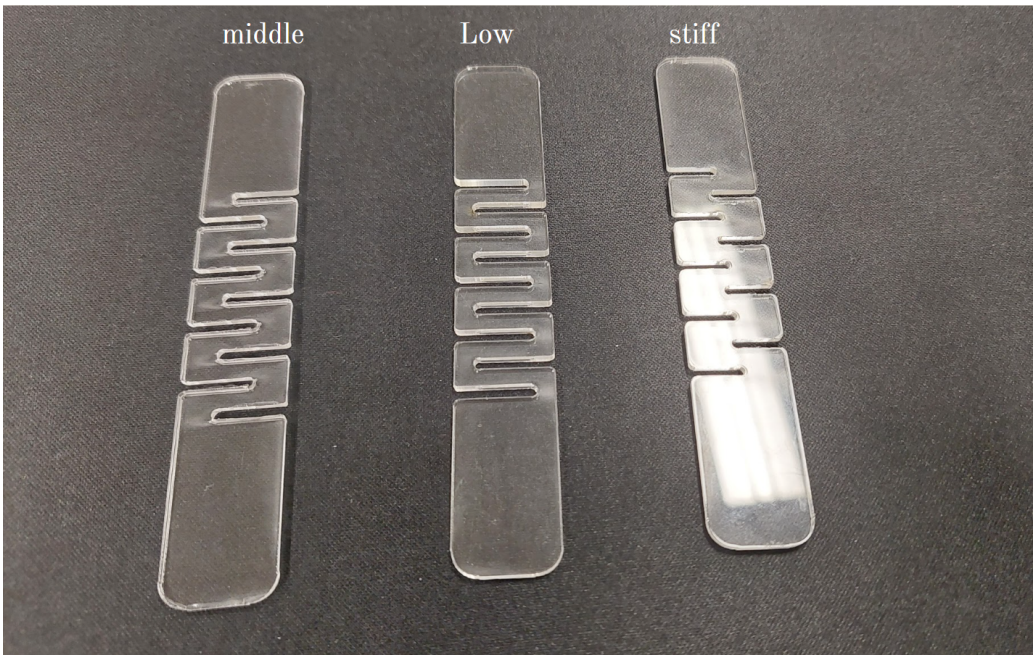

Fig. 11. Bonings of different stiffness. The stiffness is adjusted by changing the width of the living hinge structure.