Dexterity Project: Twitchy Gamer

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Abstract

Human dexterity is essential to our daily lives, and the complexity of hand movements has been a great focus for robotics studies. Our need-knower has suffered from a hand-trembling problem that affects some essential tasks in his daily life, especially gaming. In this paper, our team will propose an assistive device in addressing the problem of hand trembling while gaming. While trembling hands are more common among older adults due to Parkinson's disease, we suspect that hand trembling due to unknown reasons can also happen at a young age. Therefore, after interviewing our need-knower and researching, our team decided to design a task-specific passive wrist guard that helps stabilize the wrist when holding a mouse.

I. Introduction

Trembling hand is a common medical condition that affects millions of people worldwide. It is a condition characterized by involuntary shaking or tremors of the hands or fingers. According to the National Institute of Neurological Disorders and Stroke, essential tremor is the most common type of trembling hand, affecting up to 10 million people in the United States alone [1]. Trembling hands can have a significant impact on a person's daily life, making it difficult to perform simple tasks that require fine motor skills like writing, drinking, eating, or gaming. In severe cases, it can lead to social isolation, depression, and anxiety.

Hand Trembling can occur due to a variety of factors, such as anxiety, stress, fatigue, neurological disorders, medication side effects, or alcohol withdrawal [2]. The condition can be temporary or persistent and can vary in severity from mild to severe. Overall, trembling hands can be a challenging condition to deal with, and it can significantly impact a person's quality of life if left untreated.

A. Background

There are different types of trembling hands, including essential tremors, Parkinson's disease tremors, and dystonic tremors, each with unique causes and symptoms [3]. Treatment options for trembling hands depend on the underlying cause and may include medication, lifestyle changes, physical therapy, or surgical interventions. With proper treatment, it is possible to manage the symptoms and improve a person's quality of life. There are several treatment options available, including medications like beta-blockers, anticonvulsants, and tranquilizers. Physical therapy, deep brain stimulation, and other surgical interventions may also be recommended in some cases. With proper diagnosis and management, most people with trembling hands can achieve significant improvements in their symptoms and quality of life.

In our need-knower's case, his hand trembling problem occurs when he grasps with a large force. Knowing that he does not have any other physical condition that could have caused this problem, physical therapy methods such as using a hand grip didn't help him to gain grasp strength, so his hand trembling problem remains unsolved. From the interview, he does not experience too many inconveniences in daily life except using chopsticks and playing games involving accurate aiming with a mouse.

B. Overview

The rest of this paper discusses an assistive device our team purposed for moderate hand-trembling symptoms when using the mouse. In Section II, we will talk about the interview process with our need-knower and summarize the priority needs. In Section III, we'll discuss the proposed device and test methods. In Section IV, our final prototype will be displayed. Finally, in Sections V and VI, we will summarize the intellectual merit and broader impact of our project respectively.

II. Interview case study

We interviewed a 21 years old college student who has been struggling with a hand trembling problem. In this section, details about the experience he explained to us during the interview will be discussed.

Questions were asked during the interview, and the need-knower's answers were scripted in a manner that almost every word he said was captured. Then his answers were interpreted by us into needs he might require, which is shown in **TABLE 1**. After grouping and analyzing the interpreted needs, we summarize Leo's needs in Hierarchical order as the following:

1) Wrist stability
2) Grip strength
3) Task specific
4) Comfort
5) Mobility

We've decided these are the most important features and needs because considering our need-knower's daily activities, he is only concerned when using a mouse or chopsticks when his hand will shake unwillingly, which means he needs assistance to stabilize his wrist and grip. Moreover, since an assistive device is not needed all the time, we need to consider the mobility and comfort of the device to make sure it can be easily worn and carried around. Finally, given the budget and time available for product development, aspects such as cost, realism, and complexity are also important factors when it comes to concept selection.

Questions	**Interviewee statement**	**Interpreted need**
Can you shortly explain what kind of problem you are facing?	When I apply more force, typically grasping or fully extending my fingers, my hand will shake. So when I am playing first-person shooter games, my aim will be very shaky and that's my biggest problem with it. Also, when I am using chopsticks my hand will shake too, so eating sometimes is a bit painful.	• The user needs a device to provide hand stability (gaming) • Assistant for grasping (daily activities such as eating with chopsticks)
What assistive device have you used?	I used a hand grip for one month but it didn't really help with my grip strength.	• Therapy devices in the market are not very helpful. • An assistive device might be preferred.
Which part of the hand do you feel is very controllable?	My fingers are fine. They don't shake or anything. It's mainly my wrist that will shake when it's tilted upward by about 40 degrees, or when I need some grip strength.	• Controlling the wrist is more important than the fingers • Wrist stabilization when the activity requires decently high grip strength.
When do you feel like you need an assistant device?	Gaming (Mouse and keyboard), using chopsticks, and writing is fine but in terms of drawing straight lines, I cannot hold the position well	• The device should be task-specific. • The device can be used for multiple tasks without making him uncomfortable.
Do you think a device that you can carry around is better or a device that is fixed at your workstation better?	I would prefer something that I can carry with me. For example, if I go out and eat with chopsticks, I need to carry that with me.	• Mobility on the device is desirable.

TABLE I: Interview Summary

During the design phase, we followed up with the need-knower with a few more details. We informed him that the assistive device will mainly help him with better wrist stabilization while using a mouse. One important fact is that because of his trembling problem, he has been using the mouse with his arm

as a pivot point instead of lying the wrist on the table. As illustrated in **Fig. 1**, the blue shaded area indicates the contacting supporting point while using a mouse, and the drawing on the right describes our need-knower's situation.

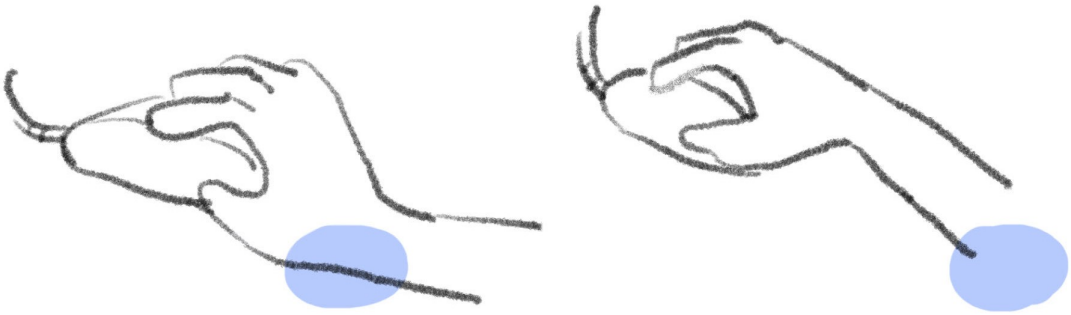


Fig. 1: Hand contact point when using a mouse

III. Proposed Device & Test Methods

A. Proposed Device

After brainstorming and comparing ideas, our team has decided to develop a hard-shell wrist guard with springs attached, which is able to support and stabilize trembling hands at the wrist. Unlike the traditional wrist guards that limit the wrist's flexibility, our concept is to allow the user to have full wrist rotation motion while damping the involuntary shaking.

Shown in **Fig.2**, the concept includes a simple shell that is equipped around the user's hand with springs attached to provide supportive force at the wrist. This device is comfortable, portable, and can be used with different tasks to provide wrist stability. The springs used in the device are carefully selected to provide the optimal level of support for individuals with trembling hands, while also allowing for free movement of the wrist. The hard-shell design of the wrist guard also ensures durability and protection for the user's hand. This proposed device has the potential to significantly improve the trembling hands of our need-knower by providing a comfortable and effective method of stabilizing the wrist during everyday activities.

B. Test Methods

To test the effectiveness of our proposed hard shell wrist guard, we conduct tests on the shape of the device as well as the force experienced for damping. The testing plan involves the need-knower performing a series of tasks both with and without the wrist guard to determine its effectiveness in providing wrist stability and reducing tremors. The tasks will include using chopsticks to pick up small objects, playing shooting games on a video game console, and performing simple tasks such as writing and typing on a keyboard. We will record the time taken to complete each task and compare the results between the two conditions (with and without the wrist guard). The need-knower will also be asked to rate their level of comfort and stability during each task, using a numerical rating system. Through testing with the prototype, we will be able to fine-tune the design and ensure that it met the needs of our need-knower. We hope to demonstrate the effectiveness of our proposed device in improving the daily lives of those with trembling hands.

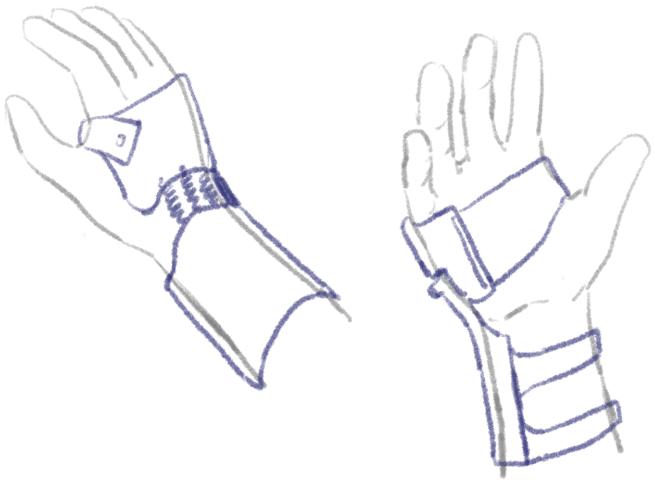


Fig. 2: Device concept sketch

IV. Prototype

We first wanted to create a low-fidelity prototype made of clay and springs because with the clay, we can shape the hard pieces ergonomically to make them fit better with human arm. But when the clay is drying, with such a thin and curvature shape, the pieces have cracks and finally collapse when loaded with springs. Then we made the second low-fidelity prototype with cardboard and rubber bands (**Fig. 3**). Because of the ease of making such prototype, we are able to cut a few different shapes of the cardboard and also place rubber bands at different locations to test out how the tremble damping will be affected. In addition, we found that rubber bands are extremely flexible, while springs would provide too much resistance to wrist motion, so we decided to use rubber bands in the final prototype. The final prototype

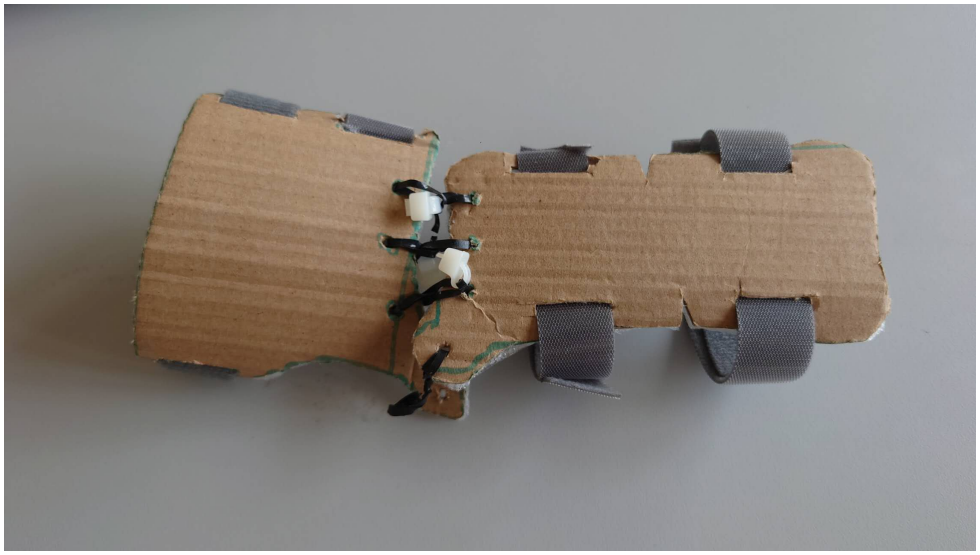
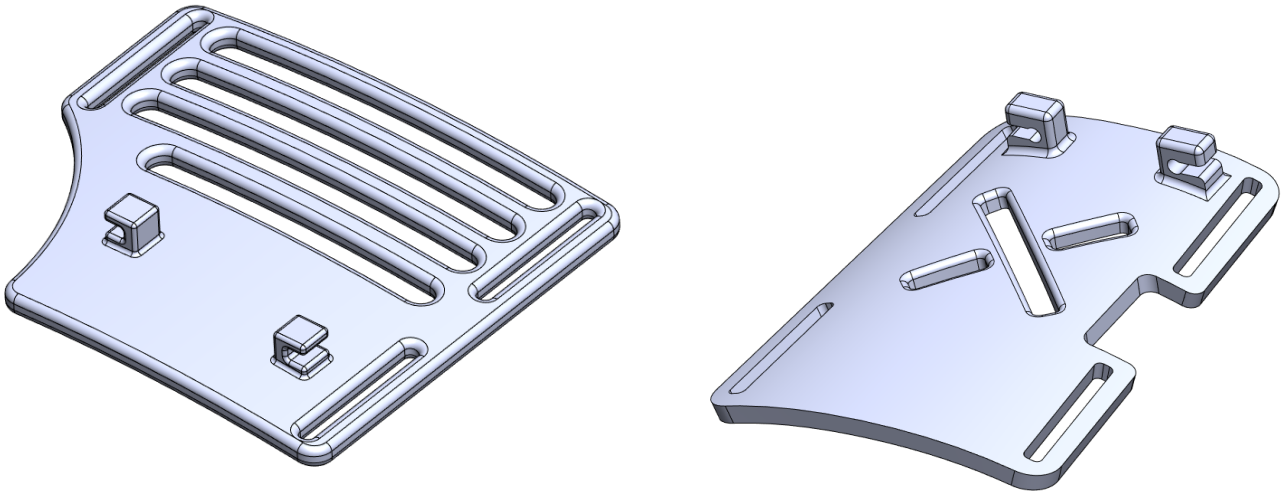


Fig. 3: First Prototype

was designed to be comfortable and easy to use, with a simple two-piece hard shell equipped around the user's hand and wrist. **Fig.4 (a)** is the piece placed on the dorsal, and **Fig4 (b)** is the piece placed on top of the arm. There are two hooks on each piece that give the user the flexibility to change or reattach rubber bands. The prototype uses a Velcro band to tighten the device on the user's hand and wrist. The

resin material used in this prototype was chosen for its pliability and durability, allowing us to shape and refine the device as needed.



(a) hand piece (b) arm piece

Fig. 4: CAD drawing of prototype

Shown in **Fig.5**, the 3D-printed prototype uses velcro band to tighten the device on the user's hand and wrist. Multiple soft foam layers are inserted below the hard shell to make the device more comfortable. **Fig.5 (b)** corresponds to our need-knower's situation addressed in **Fig.1**, the rubber bands will only be engaged when the hand flexes, and when the hand is in extension, there will be no resistance provided by the device.

(a) Top view (b) Side view

Fig. 5: Prototype display for user posture

While holding the mouse, the hand is not subject to motion in the transverse axis, so our main concern is to dampen the trembling motion in the sagittal axis. By adjusting the location of the hooks, the two leftmost rubber bands, **Fig. 5** are stretched at larger tension, which is able to provide resistance against the sagittal small vibrations. It is also important that these rubber bands are not strong enough to pose impact and delay on voluntary motion of the wrist, so the user is still able to freely move their hand with minimum resisting force experienced. This prototype served as an important step in the development of

our proposed device, allowing us to refine the design before moving on to more advanced prototypes and eventually a final product.

Fig. 6: Prototype spring damping diagram

V. Intellectual Merit

The intellectual merit of our study lies in its potential to address our need-knower's hand tremor when playing video games using a mouse. Our proposed solution is a hardshell wrist guard with elastic materials like rubber bands attached, which serves as a passive device to dampen wrist tremors. The device is low cost, portable, and easy to use, with foam layers, ventilation holes and Velcro band to easily attach it to the user's hand and provide comfort during prolonged use. Unlike other fixation devices, our solution allows the user to move their wrist freely, with the resistance of the rubber bands only engaging during hands flexion, which is the specific gesture causing our need-knower's hand tremor. Through testing, our device has shown a significant effect in dampening the shaking, although it is not able to completely stop it. Further investigation is needed to better understand the specific reasons for our need-knower's wrist tremors and to develop an improved solution. There is also potential for future research to explore other customized elastic materials that could better dampen the tremors or to investigate other methods beyond a physical device, but for the current iteration of the device, the hard shell is easily 3D-printable and the other materials used for the device are easy to access, making the design accessible to everyone that has similar problems.

VI. Broader Impact

Our study's finding have broader impact in addressing the needs of individuals with similar hand tremors and contribute to the development of more effective solutions to improve their daily lives. Our proposed device demonstrates the potential of being beneficial without causing discomfort or complications in daily life. It is designed to be used by people of any age and with any type of wrist tremor, and not limited to gaming. It can also be used in other daily activities such as writing, using chopsticks, and more. Hand tremors are a worldwide problem, and our invention is intended to be open and shared with our need-knower and others facing similar challenges, to provide them with an easy and accessible solution to help stabilize their hands. Our study could have a significant impact on improving the quality of life of people with hand tremors, and we hope to inspire further research and innovation in this area.

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