



University  
of Basel

# **Analysis and Comparison of Text-Input Methods in Virtual Reality**

## Bachelor Thesis Presentation

Nakarin Srijumrat, 16.12.1998

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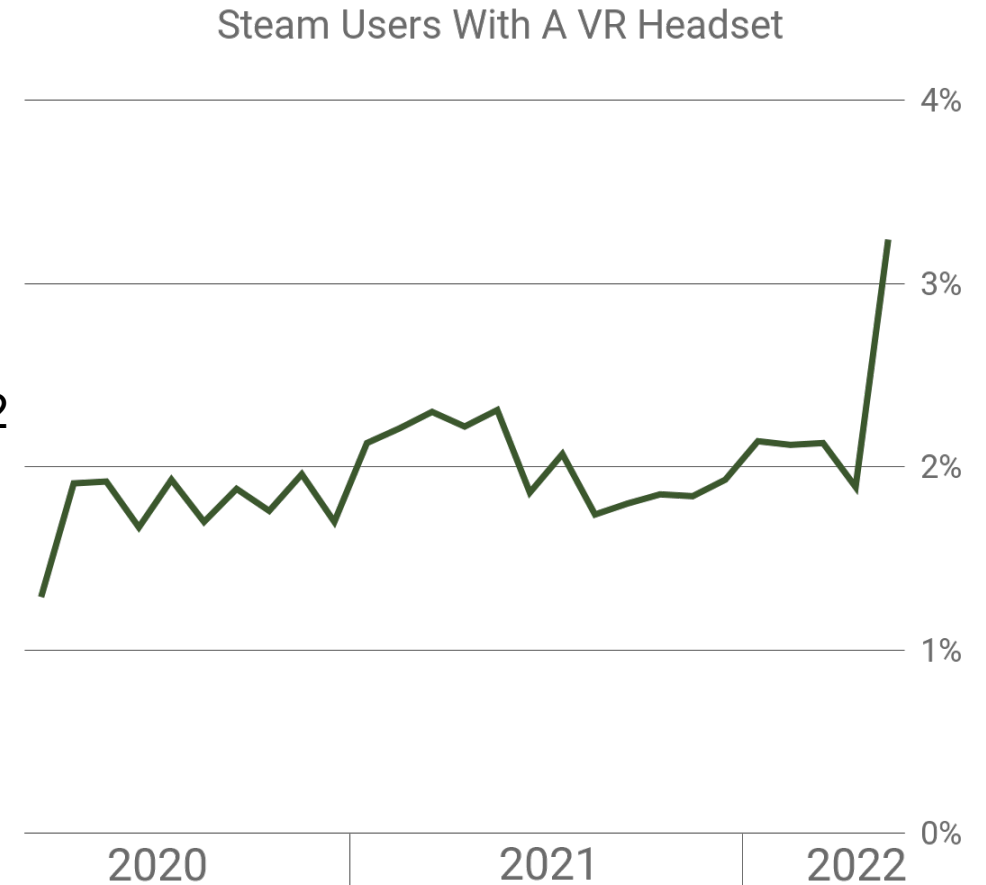
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# Intro to Virtual Reality

- Enables experiences not possible with conventional computer
  - Headset with display (+ controllers)
- First interest in VR in research 70s-80s, less in 2000s
  - Renaissance in 2010s
- 3.24% of Steam accounts connected a VR Headset in May 2022
  - Estimated: 3'888'000 of 120'000'000 total users [1]
- Use cases
  - Training and Education
  - Entertainment
  - Healthcare
  - ...



# Current state of VR Text-Input and Motivation

- Efficiency of text-input in VR insufficient:
  - Speed
  - Reliability
  - Accuracy
- Many of proposed solutions not public or developed for specific hardware
- **What can we do?**
- **Thesis Goal:** Contribute to existing research
  - **Implement** solutions (2 existing designs, 1 new design)
  - **Compare** solutions using research standards

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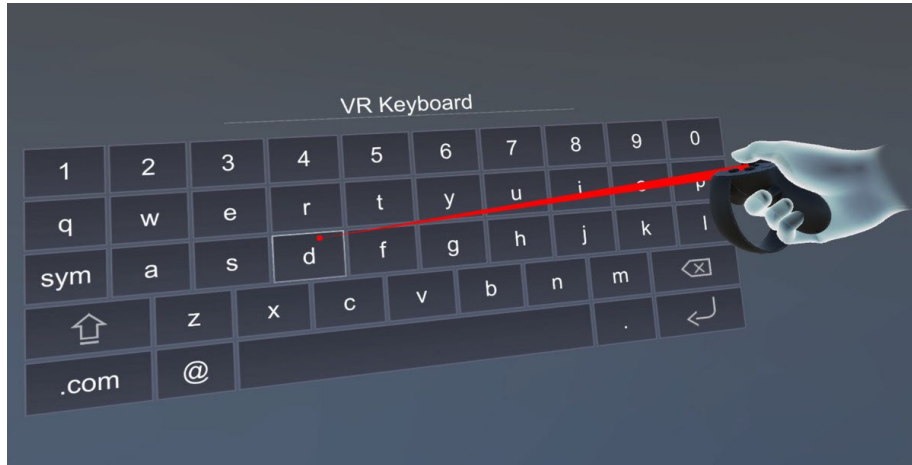
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# Established VR Text-Input Methods

## Raycast Keyboard



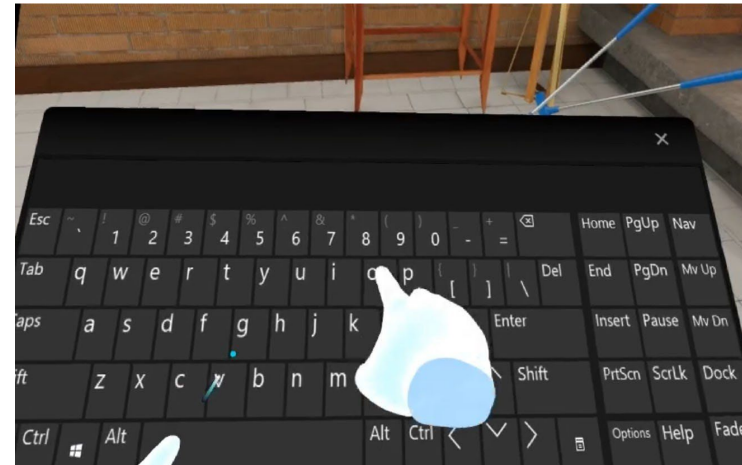
### Controller-based

«Aim and shoot»:

**Selection** with hand movement

**Confirmation** with button press

## Virtual Keyboard



### Controller-based

Modelled after physical keyboard:

**Selection** and **Confirmation** with hand movement

**Subject of thesis**

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# Implemented Keyboards

## Virtual Keyboard



Copy of a «real» keyboard

### Pros

- Widespread familiarity
- Very easy to use

### Cons

- Tiring to use

## Drumstick Keyboard [2]



Drums as keys, sticks as triggers

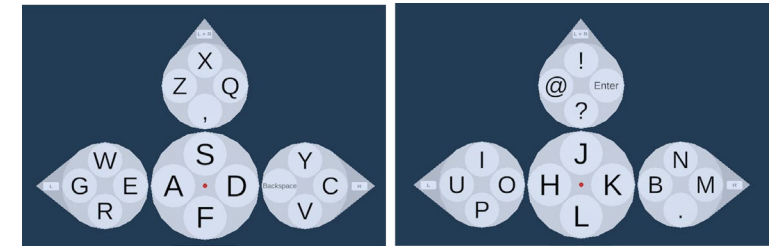
### Pros

- Less arm fatigue
- Intuitive

### Cons

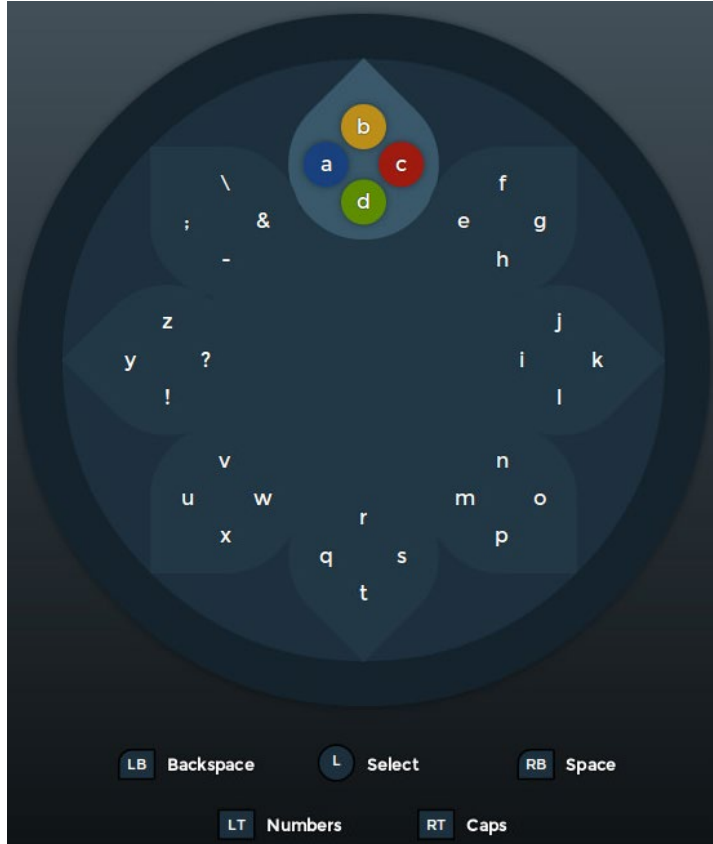
- Requires more precision

## Analog Stick Keyboard

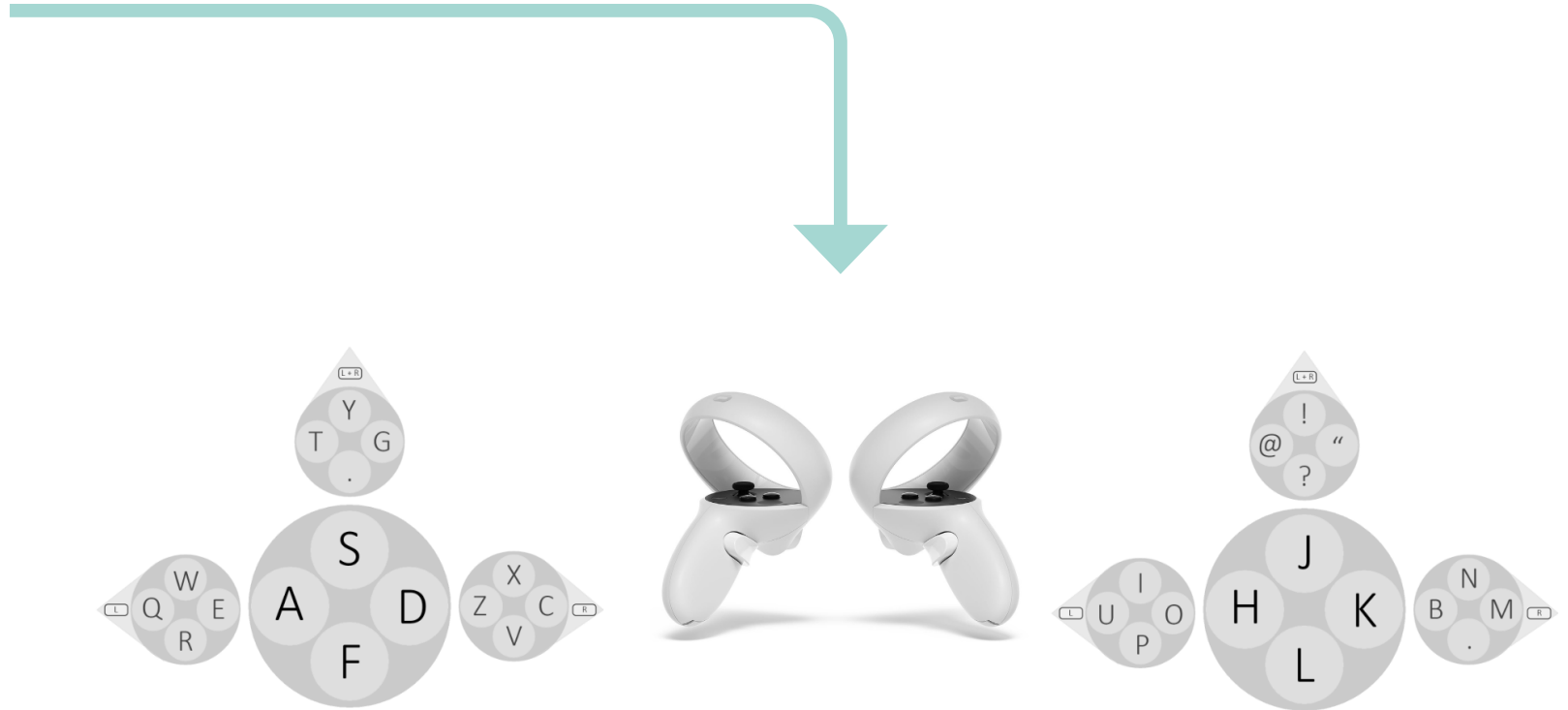


Input based on sticks and triggers instead of movement

# Inspiration for Analog Stick Keyboard



Daisywheel Keyboard (2012) by Valve [3]



# Implemented Keyboards

## Virtual Keyboard



Copy of a «real» keyboard

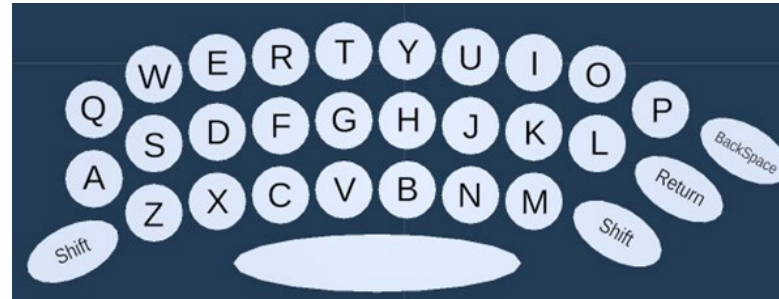
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## Drumstick Keyboard



Drums as keys, sticks as triggers

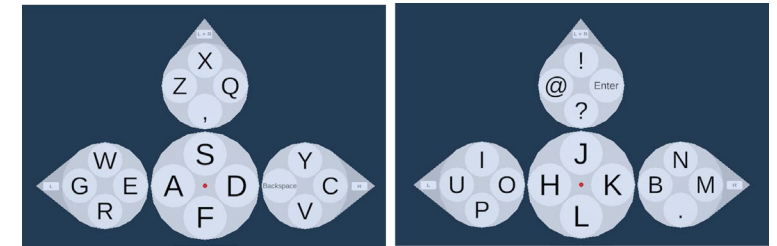
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## Analog Stick Keyboard



Input based on sticks and triggers instead of movement

### Pros

- ???

### Cons

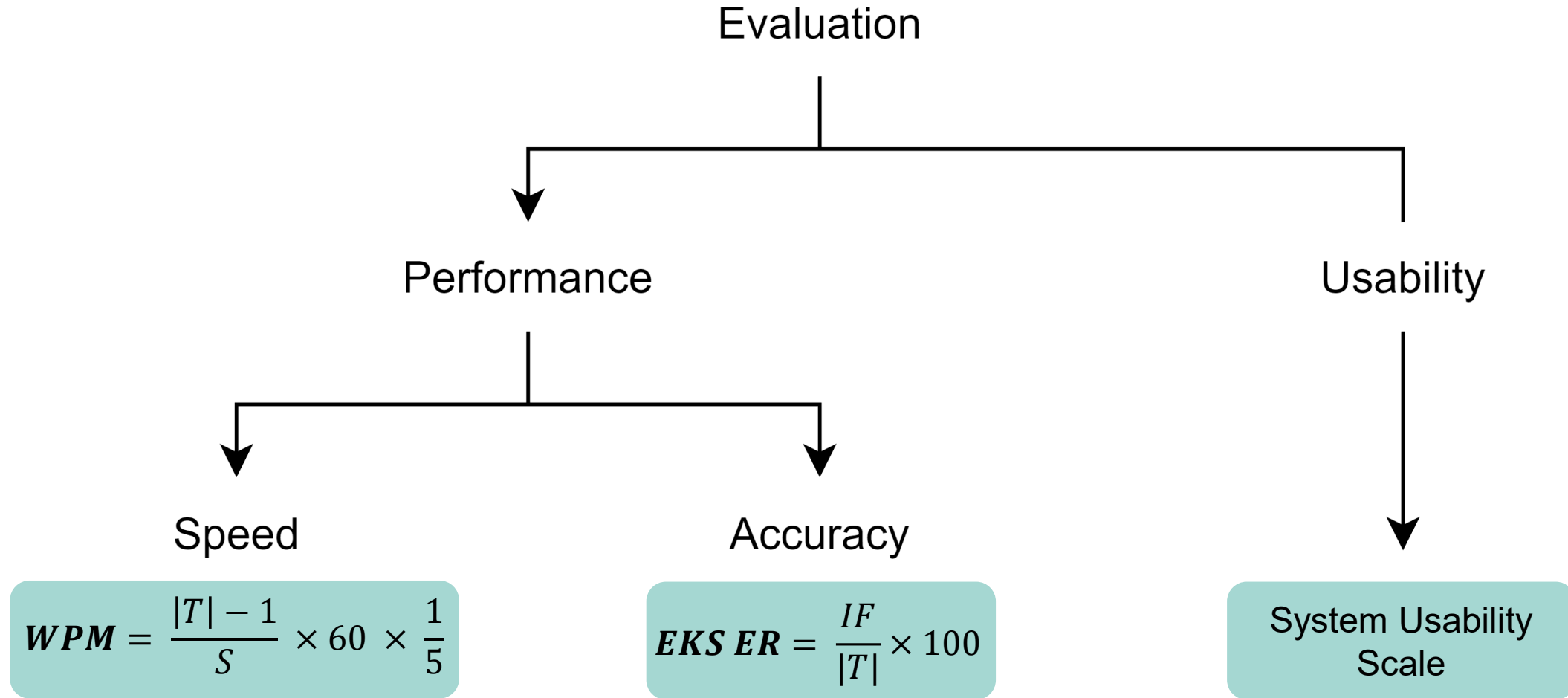
- ???

# Demo Video

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# Evaluation Methodology [4, 5]



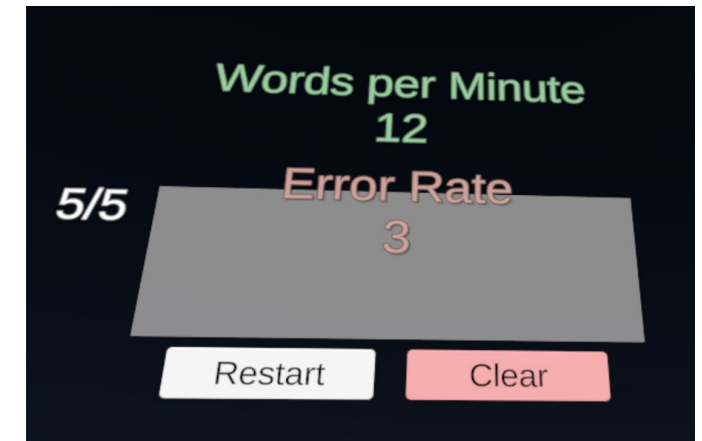
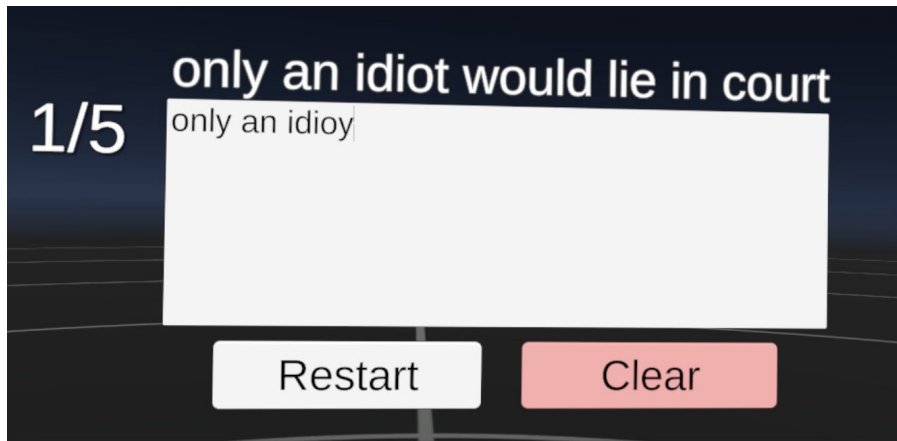
$|T|$  = Length of Input

$S$  = Seconds From First Input to Last

$IF$  = *Incorrect Fixed*

# Data Collection

- User Study, participants asked to copy phrases using identical VR hardware (n=14)
  - Phrases taken from MacKenzie phrase set [6]
- 5 phrases for Virtual/Drumstick Keyboard, 3 phrases for Analog Stick Keyboard
- **Performance** calculation based on user input
- **Usability** based on SUS questionnaire



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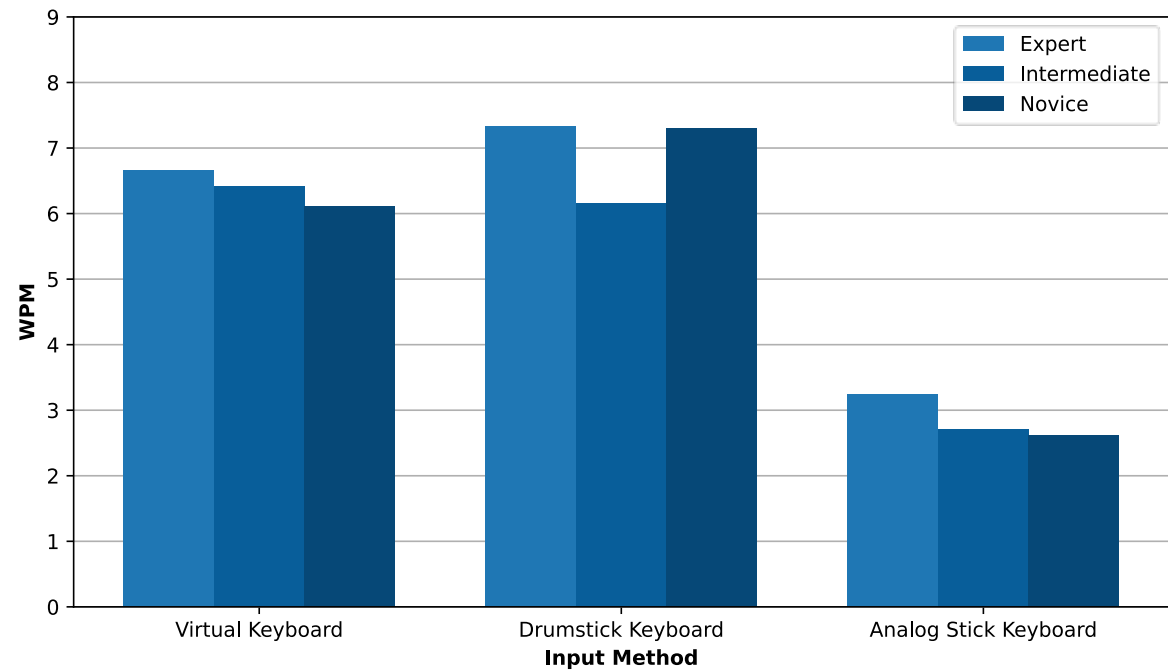
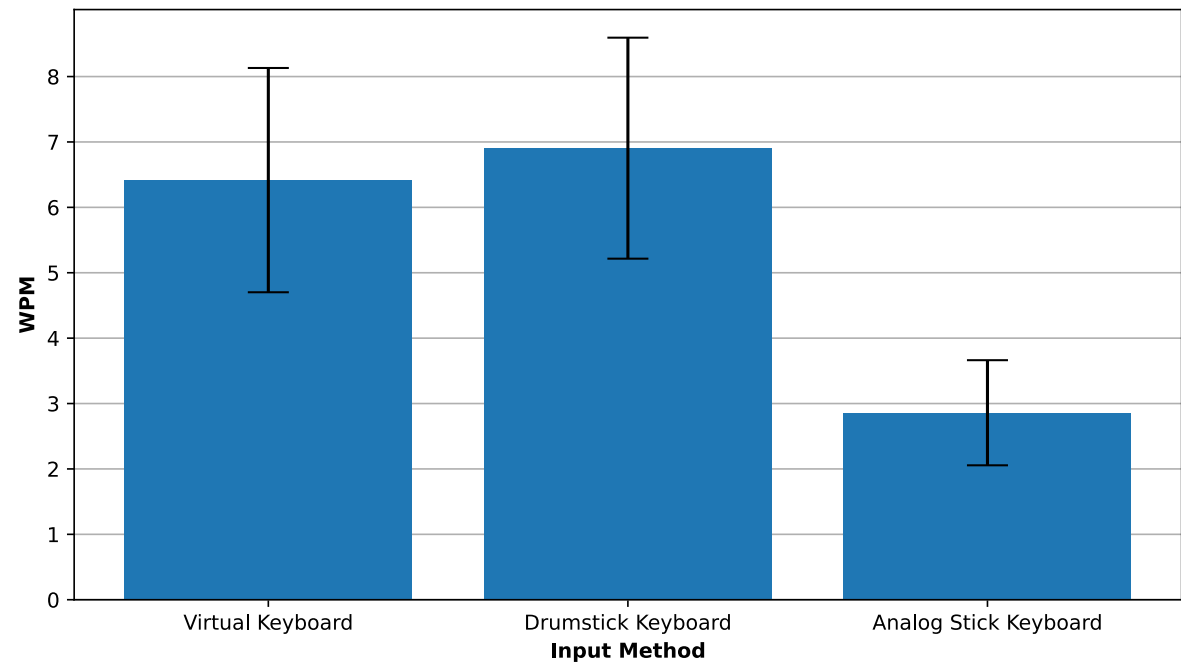
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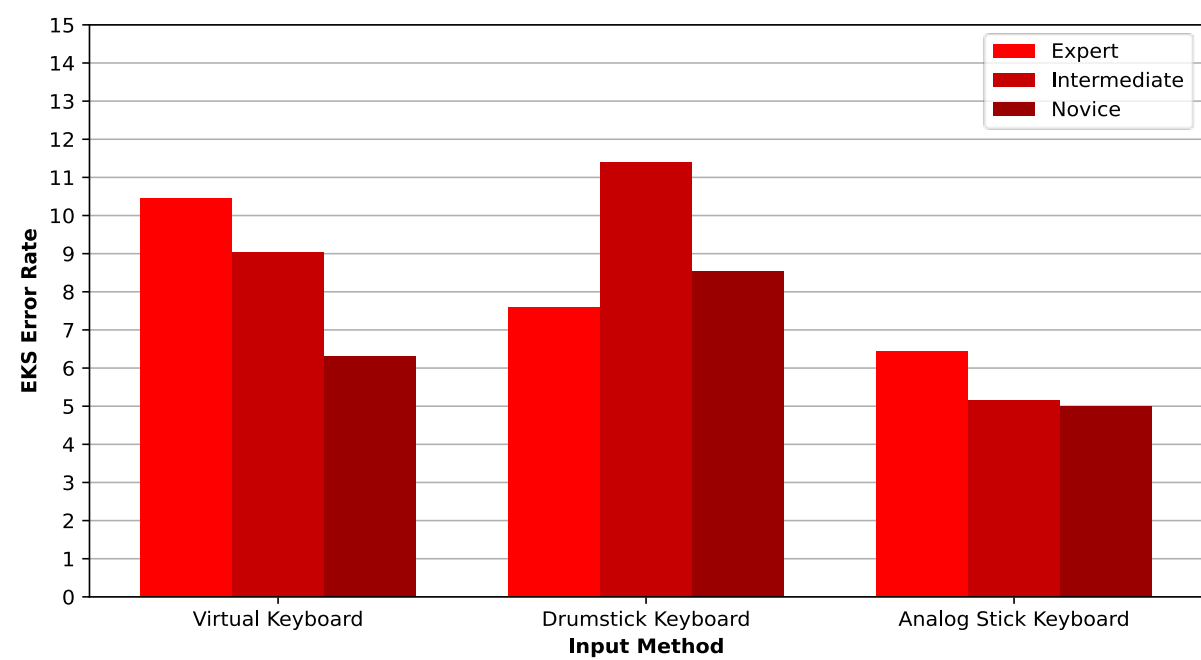
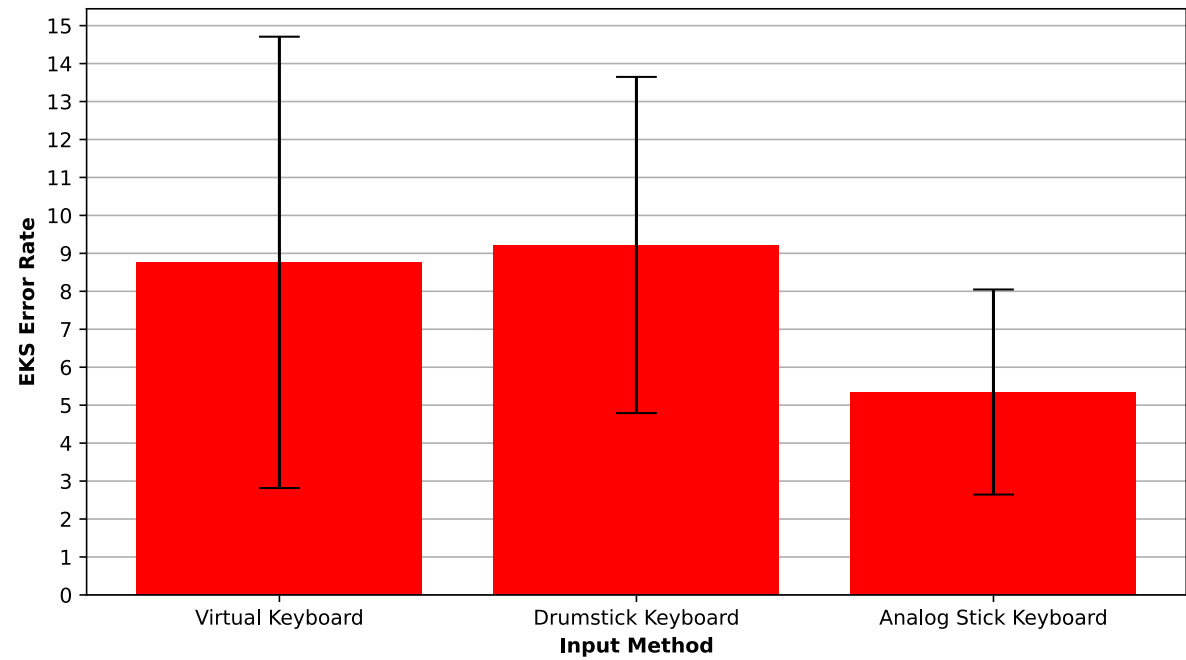
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# Performance: Text Entry Speed



# Performance: Error Rate



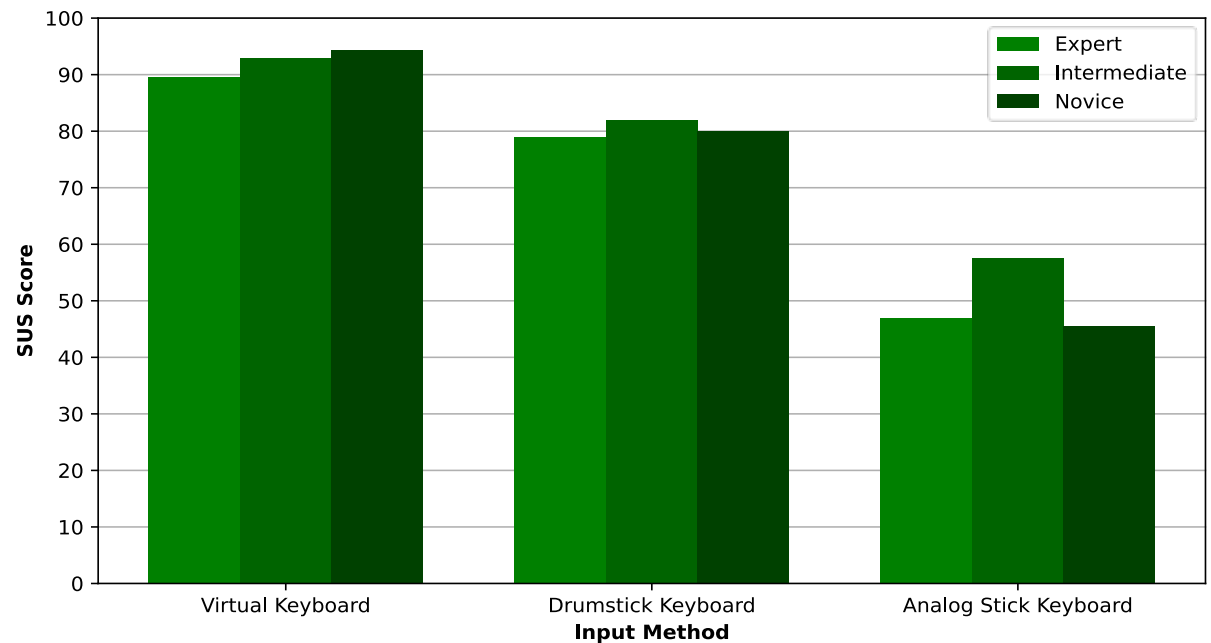
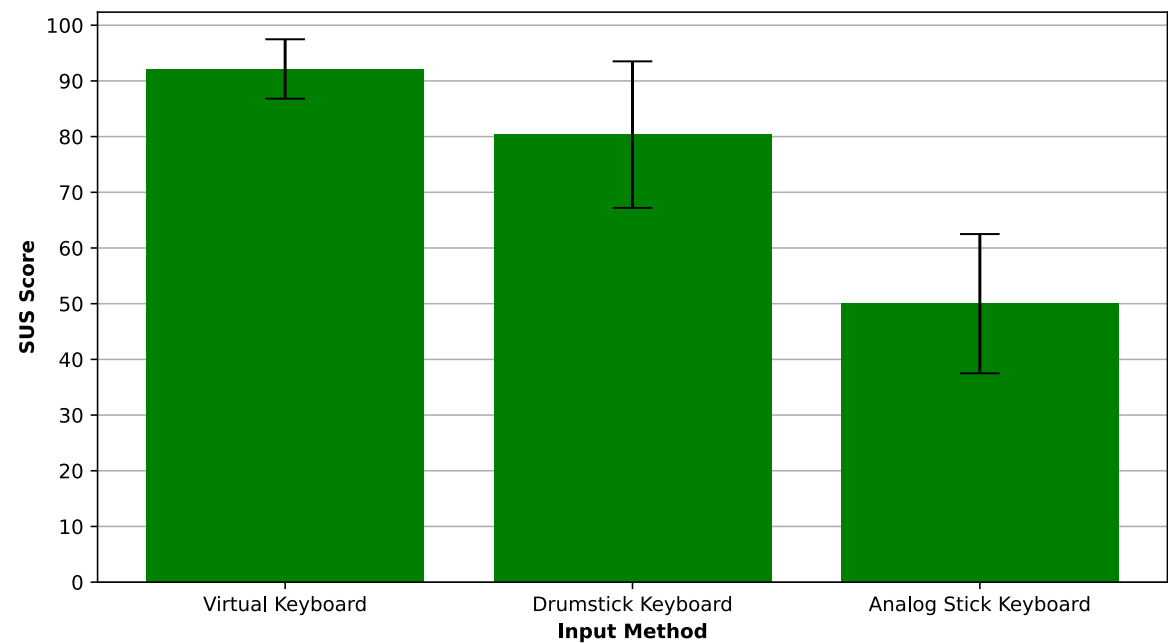
# Performance Comparison to Physical Input Methods [4]

Input Method	Participants	Error Metric	Error Rate	WPM ↓
Physical Keyboard	25	ER*	1.80	75.84
12-Key Multi-tap	55	EKS ER	9.10	9.94
<b>Drumstick Keyboard</b>	<b>14</b>	<b>EKS ER</b>	<b>9.22</b>	<b>6.91</b>
<b>Virtual Keyboard</b>	<b>14</b>	<b>EKS ER</b>	<b>8.76</b>	<b>6.42</b>
<b>Analog Stick Keyboard</b>	<b>10</b>	<b>EKS ER</b>	<b>5.35</b>	<b>2.80</b>

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Physical Keyboard	25	ER*	1.80	75.84

\*allows incorrect input

# Usability: System Usability Scale (SUS)



# Implemented Keyboards - Reprise

## Virtual Keyboard



Copy of a «real» keyboard

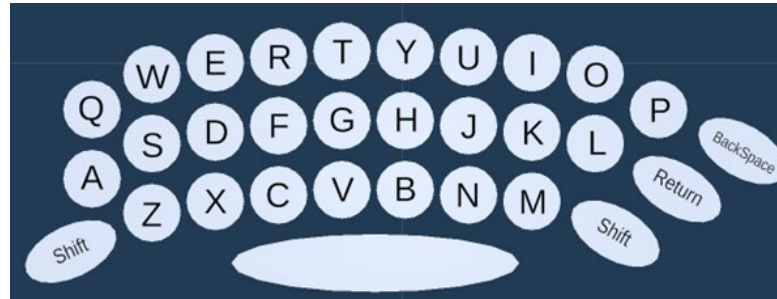
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Drums as keys, sticks as triggers

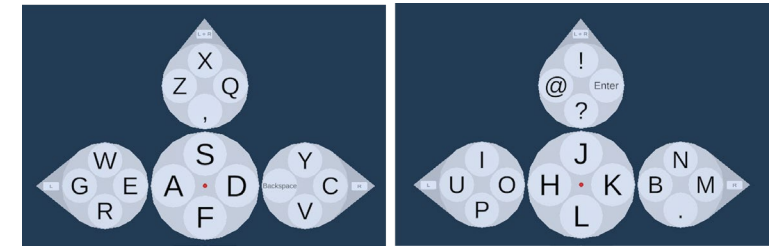
### Pros

- Less arm fatigue
- Intuitive

### Cons

- Requires more precision

## Analog Stick Keyboard



Input based on sticks and triggers instead of movement

### Pros

- Can be used blindy
- No arm movements

### Cons

- Very steep learning curve

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# Conclusion

- 2 existing designs of keyboards implemented, 1 original design implemented
- **Virtual Keyboard** ranked best in terms of usability, almost fastest and moderate ER
- **Drumstick Keyboard** was the fastest (but had the highest ER)
- **Analog Stick Keyboard** least errors, but low speed and low usability
  - Attributed to learning curve properties
- All methods significantly slower than physical keyboard

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# **(Conceptual) Keyboard Improvements**

- Haptic Feedback
- Improved Visual Feedback for Analog Stick Keyboard
- More Symbols and Capital Letters (Using Modifier Buttons)
- Alternative Layout for Analog Stick Keyboard

# Future Work

- Alternative Error Rate Measurements
  - EKS ER didn't allow incorrect copies
  - Impact on WPM
  - Different measurements highlight different factors [4]
- Exploration of other input methods
  - Countless possibilities for text input
  - Methods that come with technological advances

# References

- [1] VR Usage On Steam Jumps To All Time High - But Why? (uploadvr.com) (06 June 2022, retrieved 30 June 2022)
- [2] Andrey Doronichev. Daydream labs: Exploring and sharing vr's possibilities, May 2016. URL <https://blog.google/products/google-ar-vr/daydream-labs-exploring-and-sharing-vrs/>.
- [3] likethemammal/daisywheeljs: The Steam "Big Picture" Daisywheel ported to JS and CSS. Supports Gamepad API. (github.com)
- [4] Ahmed Arif and Wolfgang Stuerzlinger. Analysis of text entry performance metrics. pages 100 – 105, 10 2009. doi: 10.1109/TIC-STH.2009.5444533
- [5] John Brooke. SUS – a quick and dirty usability scale, pages 189–194. 01 1996.
- [6] I. Mackenzie and R. Soukoreff. Phrase sets for evaluating text entry techniques. Conference on Human Factors in Computing Systems - Proceedings, 05 2003. doi: 10.1145/765891.765971



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**Thank you**  
for your attention.