Optimizing & Personalizing Interactions in Esports

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Interactions in esports are special

In esports, the outcome of an interaction is one of two: win or lose.

Players will be matched against opponents with similar ranks.

So even a small difference in performance can lead to defeat.
Nike super spikes controversy

Also in traditional sports, small differences are critical.

Retirement of a Korean esports athlete in 2019

“I can't seem to play the game anymore due to my obsession with peripheral settings being correct.”

https://www.instiz.net/pt/6416101
http://m.dailyesports.com/view.php?ud=201706221710533833
Players are curious about professional settings, in-game settings, and etc.

https://prosettings.net/
Refining strategy through big data analysis and visualization

https://op.gg

https://nunu.gg
Lack of engineering research on esports

Analysis of titles and keywords of over 1,400 papers listed in Esports Research Network (ERN)

Credit: Mushtariybonu Shodikulova
Lack of engineering research on esports

At Korean esports conference 2022

https://sports.khan.co.kr/bizlife/sk_index.html?art_id=202204251700023&sec_id=560101
## Misleading conjectures about optimal settings and gameplay

<table>
<thead>
<tr>
<th>Aiming</th>
<th>Performance Metrics</th>
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<tbody>
<tr>
<td>A-1 &quot;When track aiming, keep the crosshairs on the target at all times.” [4, 22, 24]</td>
<td>Enemy-crosshair stickiness</td>
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<td>A-2 &quot;When flicking (snapping) aim, quickly and accurately hit a moving target before they can react.” [4, 24]</td>
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<td>A-3 “Move your mouse in the opposite direction of each weapon’s spray or recoil pattern. This compensates for the kicks during shooting.” [2, 3]</td>
<td>Amplitude of the recoil compensating movement&lt;br&gt;Duration of shooting (tapping vs. spraying)</td>
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<td>A-4 “Most professional players have their own sensitivity.” [24, 47]</td>
<td>Force inefficiency</td>
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### Character Movement

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<tr>
<td>M-2 &quot;Make your special movement combinations: Sidestep, Strafe shooting, Jumping, Crouching.&quot; [2, 3]</td>
<td>Frequency of movement combinations</td>
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<tr>
<td>M-3 &quot;Don’t reload habitually. Know the right time to reload.&quot; [13]</td>
<td>Reload efficiency</td>
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### Physical Skills

<table>
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<tr>
<th>P-1 “Most professional players use arm aiming.” [5]</th>
<th>Rotation ratio of elbow and wrist</th>
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<td>P-3 “Scan all surroundings continuously.” [6, 44]</td>
<td>Duration of fixation&lt;br&gt;Number of saccades</td>
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<td>P-4 “Stay calm and have a composure.” [6]</td>
<td>Composure</td>
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### Device and Settings

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<th>D-1 “Most professional players use low sensitivity.” [22, 47]</th>
<th>Used area of the mousepad</th>
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<td>D-2 “To minimize the stress of a player’s wrist, place a keyboard perpendicular.” [53]</td>
<td>Keyboard perpendicularity</td>
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Misleading conjectures about optimal settings and gameplay

| Aiming                                                                 | Performance Metrics                        |
|                                                                      |                                         |
| **A-1** “When track aiming, keep the crosshairs on the target at all times.” [4, 22, 24] | Enemy-crosshair stickiness               |
| **A-2** “When flicking (snapping) aim, quickly and accurately hit a moving target before they can react.” [4, 24] | Angular velocity of the mouse            |
| **A-3** “Move your mouse in the opposite direction of each weapon’s spray or recoil pattern. This compensates for the kicks during shooting.” [2, 3] | Amplitude of the recoil compensating movement |
|                                                                      | Duration of shooting (tapping vs. spraying) |
| **A-4** “Most professional players have their own sensitivity.” [24, 47] | Force inefficiency                        |

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Research vision

Scientific theories and models of human-computer interaction

Optimization & Personalization

Game Playing
Educating & Nurturing
Training
Scouting
Interaction engineering beyond interaction design

Given enough time, we can always find a suitable solution.

But in order to find the best solution, we must truly understand the underlying mechanisms of the phenomenon.
Bayesian decision theory explains esports process

Bayesian decision theory explains esports process

Expected reward (ER):

$$ER(d) = \iiint r(a', w) f(a' | a) f(x | w) \pi(w) da'dxdw$$
Bayesian decision theory explains esports process

Expected reward (ER):

\[ ER(d) = \iint r(a', w) f(a' | a) f(x | w) \pi(w) \, da' \, dx \, dw \]

Optimizing and personalizing interactions in esports is about maximizing the expected rewards of players.
All factors must be considered simultaneously

To maximize:

\[ER(d) = \iiint r(a', w) f(a'|a) f(x|w) \pi(w) da'dx dw\]

(1) Cognitive-physical characteristics of players
(2) Decision function of players
(3) Intrinsic motivation of players
(4) Interaction prior
One widespread myth: “we must achieve zero end-to-end latency”

1D moving-target acquisition task:

A moving target repeatedly respawn with a time period \( p \) 

\[ v \] speed of the target

One widespread myth: “we must achieve zero end-to-end latency”

1D moving target acquisition task:

A moving target is repeatedly resampled with a time period $t$.

$v$: speed of the target

One widespread myth: “we must achieve zero end-to-end latency”

When the latency is too low, the target acquisition error rate is higher than when there is a moderate amount of latency (60 to 80 ms).

One widespread myth: “we must achieve zero end-to-end latency”

Effect of latency in moving-target acquisition

One widespread myth: “we must achieve zero end-to-end latency”

Effect of latency in moving-target acquisition

So, where should we start?

Imagine an abstract space that contains all the tasks given to players in esports
So, where should we start?

Then we will be able to sort the tasks according to the length of time required to complete them.
So, where should we start?

I suggest we start by optimizing the interactions in tasks that fall relatively to the bottom of the graph.

Let’s focus on optimizing interaction in these tasks!
So, where should we start?

Why?

Time scale of the task

Esports task space
So, where should we start?

Regardless of the type or genre of popular games today, it can build a scientific foundation for esports that will have a lasting impact in the future.
Let’s first focus on two elementary tasks in esports

**Button pressing**

In a single League of Legends match, a player performs approximately 8,000 point-and-clicks and 4,500 keyboard button presses!
Mechanism of a button-press

Neuromechanic model of a button press

Mechanism of a button-press

Cue-integration process

Mechanism of a button-press

Actual implementation in Matlab using Simulink
Mechanism of a button-press

Assumption:

With better button pressing, players can better expect when the button will be activated.

\[ \min_{\theta, p_c} E_P = |p_{c_e} - p_{c_o}| \]

Mechanism of a button-press

Optimization process
# Mechanism of a button-press

## Findings

<table>
<thead>
<tr>
<th></th>
<th>Linear</th>
<th>Tactile</th>
<th>Touch</th>
<th>Mid-air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptual error</td>
<td>47 ms</td>
<td>40 ms</td>
<td>34 ms</td>
<td>178 ms</td>
</tr>
<tr>
<td>SD of perc. error</td>
<td>31 ms</td>
<td>26 ms</td>
<td>76 ms</td>
<td>47 ms</td>
</tr>
<tr>
<td>SD of activation time</td>
<td>52 ms</td>
<td>43 ms</td>
<td>90 ms</td>
<td>51 ms</td>
</tr>
<tr>
<td>Activation success</td>
<td>92%</td>
<td>82%</td>
<td>94%</td>
<td>54%</td>
</tr>
<tr>
<td>Peak muscle force</td>
<td>1.65 N</td>
<td>1.41 N</td>
<td>2.6 N</td>
<td>2.9 N</td>
</tr>
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</table>

Optimizing button presses

Impact activation technique

Optimizing button presses

Button-pressing performance improved with impact activation

Mechanism of a point-and-click

It is a combination of reaching + clicking process

Mechanism of a point-and-click

Intermittent motor control process


Mechanism of a point-and-click

Click planning and execution process

Mechanism of a point-and-click

Reward per each control step

\[ R = \begin{cases} R_m & \text{Decided not to click} \\ R_s + R_m & \text{Successful click} \\ R_f + R_m & \text{Failed click} \end{cases} \]
Mechanism of a point-and-click

Approximating point-and-click behavior that maximizes the expected cumulative reward with Deep reinforcement learning

Simulating point-and-click behavior

Some of trajectories:

<table>
<thead>
<tr>
<th>Model</th>
<th>Human</th>
<th>Model</th>
<th>Human</th>
<th>Model</th>
<th>Human</th>
<th>Model</th>
<th>Human</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our model</td>
<td>ICP</td>
<td>participants</td>
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Red: target
Black: cursor

Simulating point-and-click behavior

Video:

A Simulation Model of Intermittently Controlled Point-and-Click Behavior

submitted to CHI’2021
Optimizing mouse sensitivity function

Relationship between mouse body speed and pointer speed:

\[ \nu_{\text{pointer}} = f(\nu_{\text{mouse}}) \cdot \nu_{\text{mouse}} \]
Optimizing mouse sensitivity function

Relationship between mouse body speed and pointer speed:

\[ v_{\text{pointer}} = f(v_{\text{mouse}}) \cdot v_{\text{mouse}} \]
Optimizing mouse sensitivity function

Response from 14 professional players:
Optimizing mouse sensitivity function

Submovements in pointer trajectory due to human intermittent motor control

Optimizing mouse sensitivity function

AutoGain technique

Optimizing mouse sensitivity function

AutoGain technique in action

AutoGain: Adapting Gain Functions by Optimizing Submovement Efficiency
Submitted to CHI2017 review

Optimizing mouse sensitivity function

Evolution of trial completion time

Optimizing mouse sensitivity function

Evolution of workload indices

Optimizing mouse sensitivity function

Optimal gain function for touchpad

Research vision

Scientific theories and models of human-computer interaction

Optimization & Personalization

Game Playing

Educating & Nurturing

Training

Scouting
Research vision

Scientific theories and models of human-computer interaction

Optimization & Personalization

Already a big business!

- Game Playing
- Educating & Nurturing
- Training
- Scouting
Final remarks

Over the past few decades, video games have driven advances in computer technology.
Now, esports is asking us to look back and reflect on our understanding of human-computer interaction.

Please visit
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