

UNIVERSITÄT
BAYREUTH

Effectiveness and efficiency of Table Tennis serve training in Virtual Reality and skill transfer to the real world

Author:
Praksh Verma
1554120
University of Bayreuth

Author:
Praksh Verma
1554120
University of Bayreuth

Master Thesis

Angewandte Informatik VIII

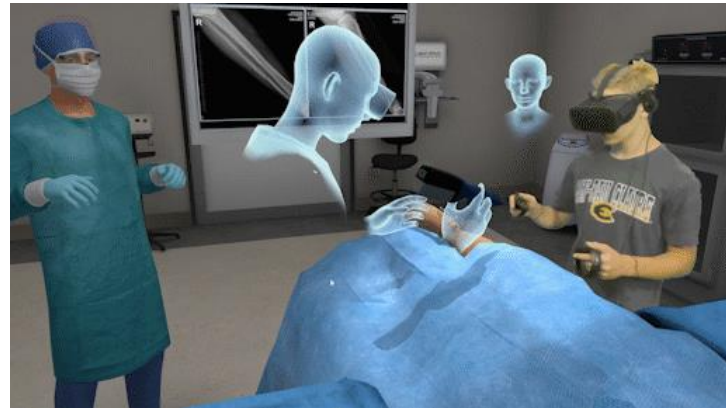
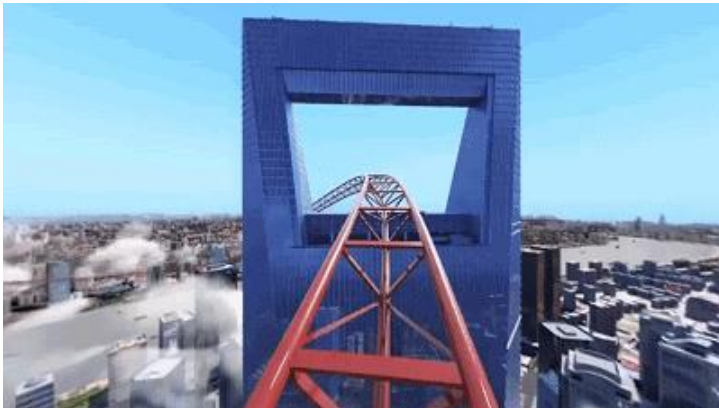
Faculty of Mathematics, Physics, and Computer science

Agenda



1. **Introduction**
2. **Literature Review**

Introduction - Motivation , and scientific contact



Introduction -

"Did the after VR training users perform significantly better for table tennis serve?"

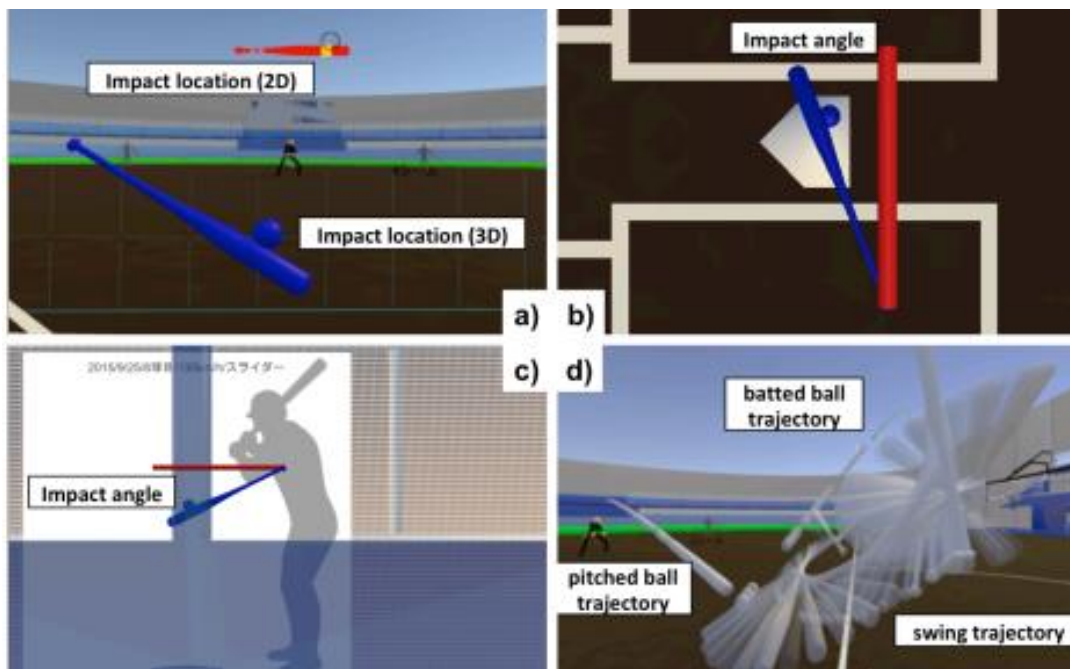
Literature Review



[Image2]

Literature Review

VR Training in Baseball:



Literature Review

- **VR Training in Basketball:**



[Image3]

Group	Initial Value	Test Value
VR Group	53.9	59.6
Contrast Group	54.7	56.2

Literature Review

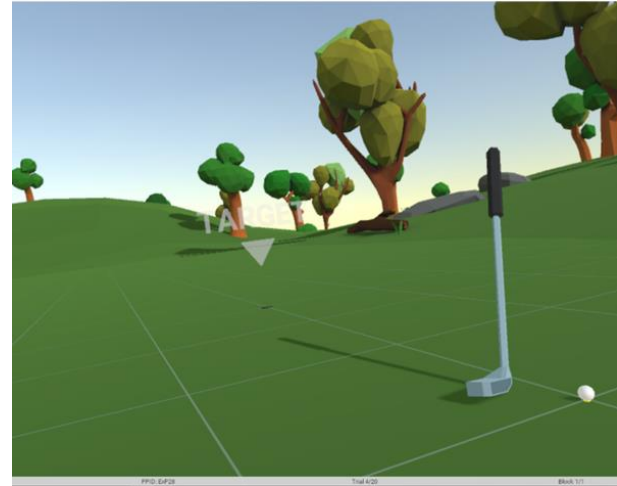
- **VR Training in Badminton:**



[Image4]

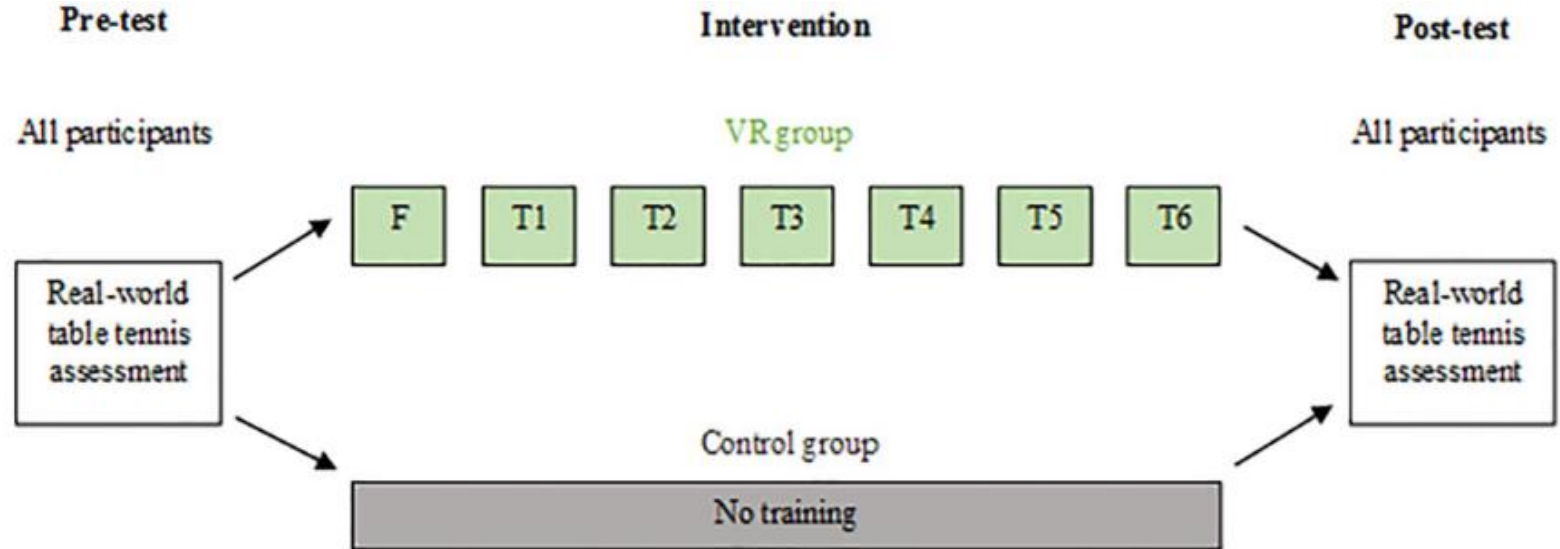
Literature Review

- Similar research has been done in **Tennis and Golf**



Literature Review

- VR Training in Table Tennis:



General Approach : Procedure

This experiment was conducted in four stages:

1. the first real-world table tennis session
2. A VR mini-game (similar to beer pong)
3. VR training[Learning]
4. the final real-world table tennis session[Measurement]

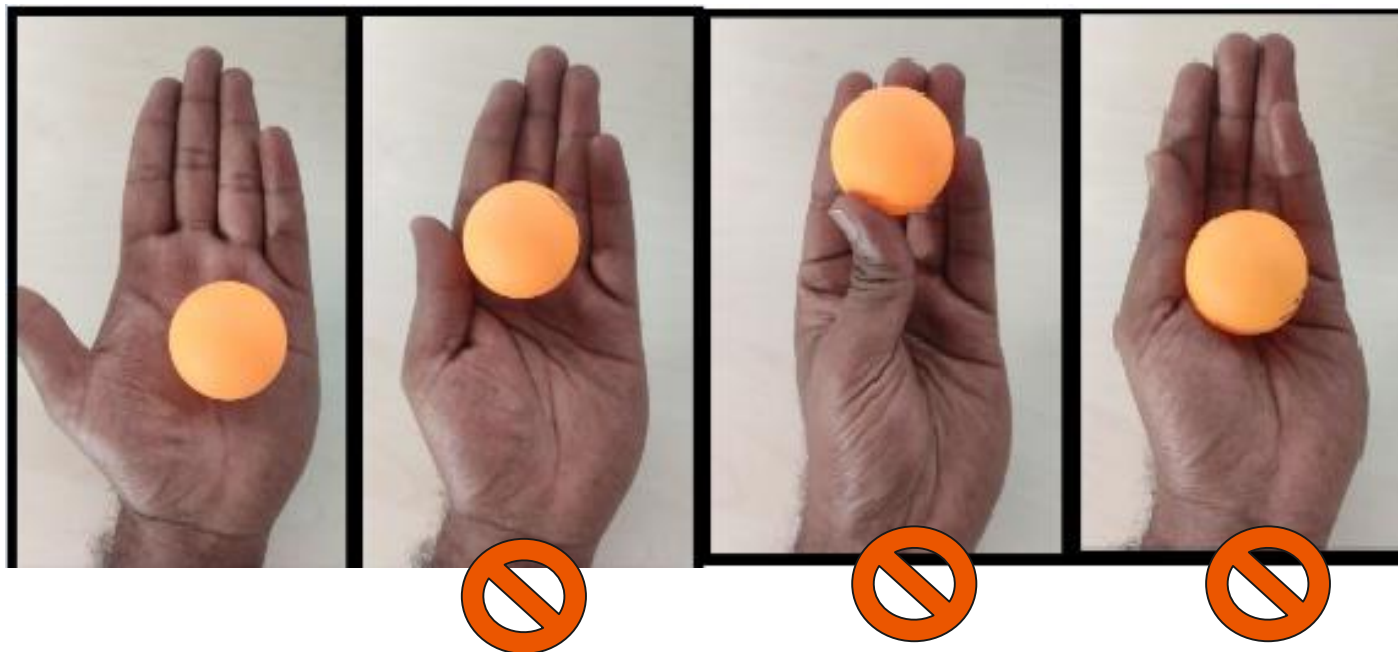
Application Design

- Real Time



User Training

In real Time: How to Serve Legally in Table Tennis



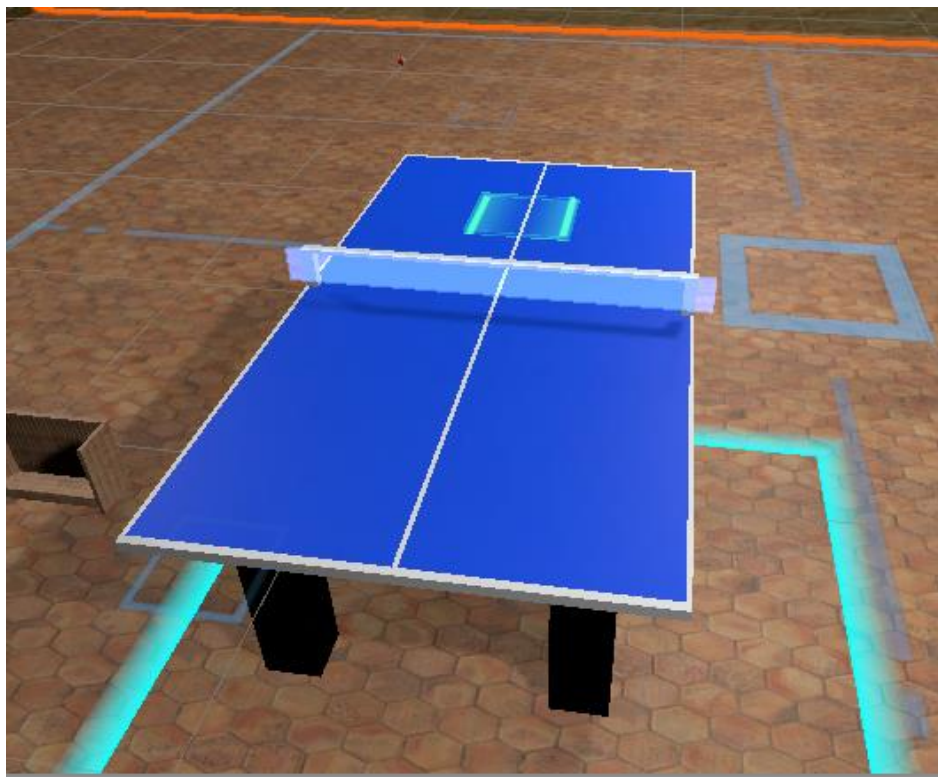
VR Environment:



User Training in VR

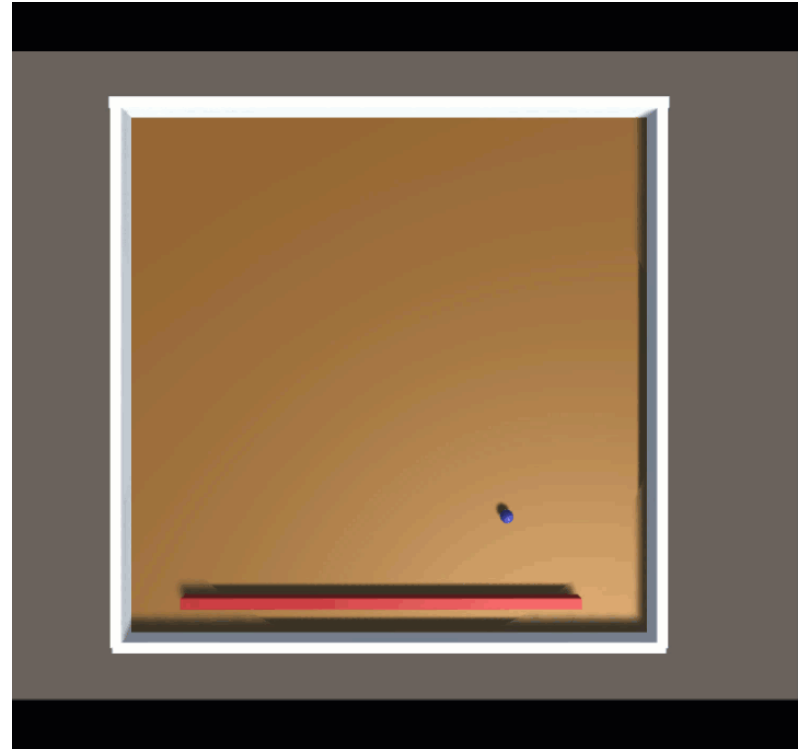


Experiment Logic



Issue occurred during VR application design:

**Continuous collision detection
(CCD)**



Experiment participation

Variable	VR training
Participants	5
Mean age	26.2
Gender	Males = 3 Females = 2
Hand preference	Right =4, Left =1

Problems that occurred during the study



- Results of the pilot user study
- Selection of participants:
- VR sickness:
- Intervals:

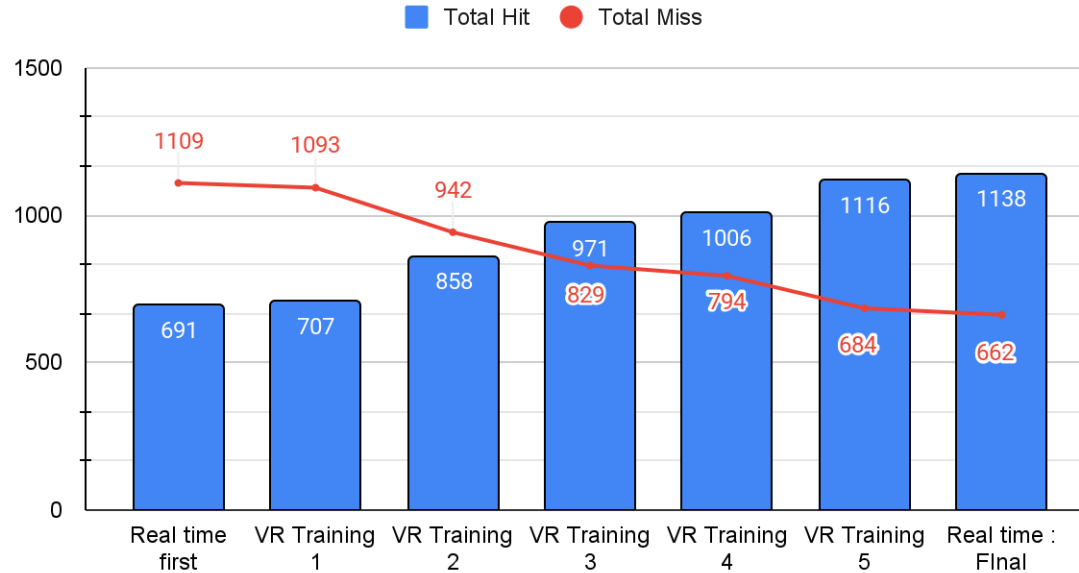
Target - Real First time	1	2	3	4	5	6	7	8	9	Total Miss	Total Hit
Attempt 1	Miss	Miss	Miss	Miss	Miss	Miss	Miss	Miss	Hit	8	1
Attempt 2	Miss	Hit	Hit	Miss	Miss	Hit	Miss	Miss	Miss	6	3
Attempt 3	Miss	Miss	Miss	Miss	Hit	Miss	Miss	Miss	Hit	7	2
Attempt 4	Miss	Hit	Miss	Miss	Miss	Hit	Miss	Hit	Miss	6	3
Attempt 5	Miss	Miss	Miss	Hit	Miss	Miss	Hit	Miss	Hit	6	3
Attempt 6	Miss	Miss	Miss	Hit	Miss	Miss	Miss	Miss	Miss	8	1
Attempt 7	Miss	Miss	Miss	Hit	Hit	Miss	Miss	Miss	Miss	7	2
Attempt 8	Miss	Miss	Miss	Miss	Hit	Hit	Miss	Miss	Hit	6	3
Attempt 9	Miss	Miss	Miss	Miss	Hit	Hit	Hit	Miss	Miss	6	3
Attempt 10	Miss	Miss	Miss	Miss	Miss	Hit	Miss	Miss	Miss	8	1
Attempt 11	Miss	Miss	Miss	Miss	Miss	Hit	Miss	Hit	Miss	7	2
Attempt 12	Hit	Miss	Miss	Hit	Hit	Hit	Miss	Miss	Miss	5	4
Attempt 13	Miss	Miss	Miss	Miss	Miss	Miss	Miss	Miss	Miss	8	1
Attempt 14	Miss	Miss	Miss	Miss	Miss	Hit	Hit	Miss	Miss	7	2
Attempt 15	Miss	Miss	Miss	Hit	Hit	Hit	Miss	Miss	Miss	6	3
Attempt 16	Miss	Miss	Miss	Hit	Hit	Miss	Miss	Miss	Miss	7	2
Attempt 17	Miss	Miss	Hit	Miss	Miss	Miss	Miss	Hit	Miss	7	2
Attempt 18	Miss	Miss	Miss	Miss	Hit	Hit	Miss	Miss	Miss	7	2
Attempt 19	Miss	Miss	Miss	Miss	Hit	Hit	Miss	Hit	Miss	6	3
Attempt 20	Miss	Miss	Miss	Miss	Miss	Hit	Hit	Miss	Miss	7	2
Attempt 21	Hit	Miss	Miss	Hit	Miss	Hit	Miss	Miss	Miss	6	3
Attempt 22	Miss	Hit	Miss	Hit	Miss	Miss	Miss	Miss	Hit	6	3
Attempt 23	Hit	Miss	Miss	Hit	Hit	Miss	Miss	Hit	Miss	5	4
Attempt 24	Hit	Miss	Miss	Miss	Miss	Hit	Miss	Miss	Miss	7	2
Attempt 25	Hit	Hit	Miss	Miss	Hit	Miss	Miss	Hit	Miss	5	4
Attempt 26	Miss	Miss	Miss	Miss	Miss	Miss	Hit	Miss	Miss	9	0
Attempt 27	Hit	Miss	Hit	Miss	Hit	Miss	Miss	Hit	Hit	4	5
Attempt 28	Miss	Miss	Miss	Miss	Hit	Hit	Hit	Miss	Miss	6	3
Attempt 29	Hit	Miss	Miss	Miss	Miss	Miss	Miss	Miss	Hit	7	2
Attempt 30	Miss	Miss	Hit	Hit	Hit	Hit	Miss	Hit	Miss	4	5
Attempt 31	Hit	Miss	Hit	Hit	Hit	Miss	Miss	Miss	Miss	5	4
Attempt 32	Miss	Miss	Miss	Miss	Hit	Hit	Miss	Hit	Hit	5	4
Attempt 33	Miss	Hit	Miss	Hit	Miss	Miss	Hit	Hit	Miss	5	4
Attempt 34	Miss	Miss	Miss	Hit	Miss	Hit	Hit	Hit	Hit	4	5
Attempt 35	Hit	Hit	Miss	Hit	Hit	Hit	Miss	Miss	Hit	3	6
Attempt 36	Miss	Miss	Hit	Hit	Hit	Hit	Hit	Miss	Hit	3	6
Attempt 37	Hit	Miss	Miss	Hit	Hit	Miss	Miss	Hit	Miss	5	4
Attempt 38	Miss	Miss	Miss	Miss	Hit	Miss	Miss	Hit	Miss	7	2
Attempt 39	Miss	Miss	Miss	Hit	Miss	Hit	Hit	Miss	Hit	5	4
Attempt 40	Hit	Miss	Miss	Miss	Hit	Hit	Miss	Miss	Hit	5	4
Total Hit	11	6	6	18	22	21	9	13	13		119
Total Miss	29	34	34	22	18	19	31	27	27	241	

Result -

	Before VR training	After VR training
Total Hit by User1	119	194
Total Hit by User2	130	276
Total Hit by User3	161	215
Total Hit by User4	122	222
Total Hit by User5	159	231

Analysis

OverAll Hits and Miss from All Participants



Real-time[Before training]

Before training Hit and Before training Miss



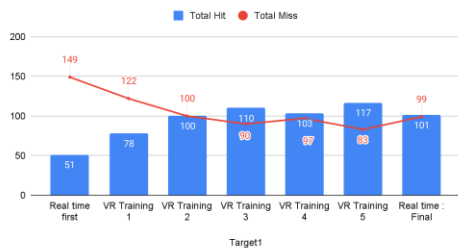
Real-time[After training]

After training Hit and After training Miss

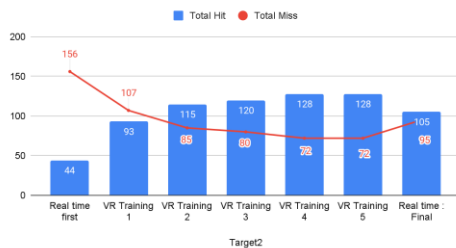


All 9 targets

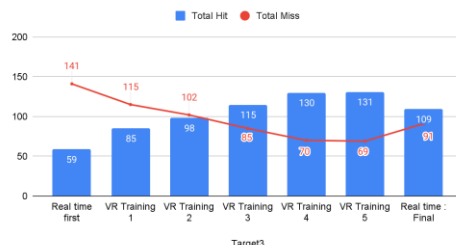
Target1



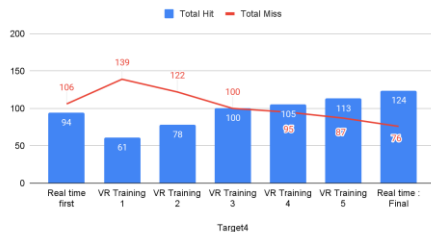
Target2



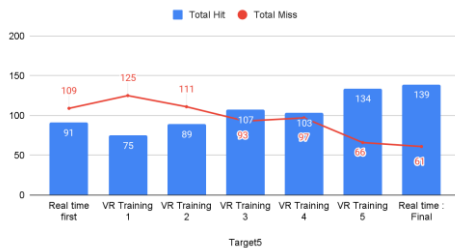
Target3



Target4



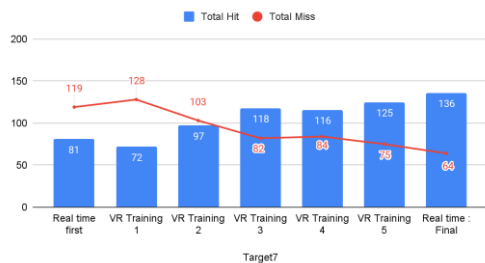
Target5



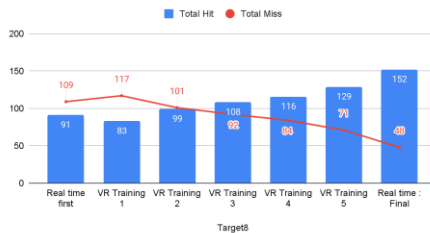
Target6



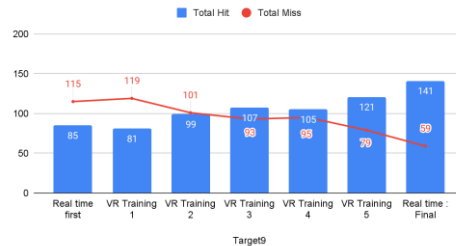
Target7



Target8



Target9



Discussion

Result:

A significant improvement was observed and the number of hits. Suppose we analyze the overall hits and misses of the participants: In real-time, the error rate reduced from 49% (from the first time) to 29% (last time). Similarly, the error rate was reduced during VR training from 48% to 30%.



Limitations

- Small number of participants.
- Field of View (FOV)
- VR sickness
- There is no rally or spin training and the participants are all beginners
- In the Unity3d game engine issue

Future Work:



1. Higher sample
2. For intermediate and expert players
3. Rally and/or spin training
4. Other sports
5. Job training for various crucial operations and tasks

Conclusion

"Did the after VR training users perform significantly better for table tennis serve?"



Thank You

QnA

000

Reference

1. Image1:<https://medium.com/vr-ar-parent-student-resource/vr-ar-parent-student-resource-3-175373e6eaf8>
2. Image2:<https://www.citavi.com/en/blog/articles/10-tips-for-writing-a-literature-review>
3. Image3: <https://medium.com/@OmniVirt/virtual-reality-vr-in-the-nba-1ccc2031a67d>
4. Image4:<https://steemit.com/steemhunt/@ememovic/badminton-kings-vr-experience-the-feeling-of-badminton-in-your-home>
5. Image5: <https://unstick.me/write-good-discussion-section/>



Thank You



T-Test:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2(\frac{1}{n_1} + \frac{1}{n_2})}}$$

- Why we have chosen the one-tail t-test:



One Tail T-test:

Did the after VR training users perform significantly better than before training?

$$p = 0.002480161$$

The most typical threshold is $p < 0.05$, which means that you should only expect to see a test statistic as severe as the one obtained by your test 5% of the time. However, the threshold depends on your field of research; certain fields demand 0.01, even 0.001.