Virtual Reality Application about Historical Fencing

Jonas Hack

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Final: Bachelor Informatics: Games Engineering

Supervisors: David Plecher, Sandro Weber

Motivation

- Historical European Martial Arts (*HEMA*)
- Educational Value due to Historicity
- Engaging Martial Art / Combat Sport
- Inaccessible to Many
- VR Training as a Supplement

Hans Talhoffer, *Fechtbuch.* 1467 [1]

Related Work

Hellish Quart [2]

Kingdom Come: Deliverance [3]

Witte et al. [4]

Takala et al. [5]

Goals of this Thesis

- Build Proof-of-Concept *VR* Application
- Evaluate *VR* as a:
  - Educational Tool for Swordsmanship
  - Training Tool for *HEMA*
  - Advantages Over Traditional Training
- Document Encountered Issues & Solutions

Symbolic Image (*CC0)*

Approach

- Tangible
  - Two-Handed Interaction Method
  - Weapon Dynamics Calculations
  - Consumer Level Manufacturing Process

- Application
  - Give an Impression of *HEMA*
  - Teach Fundamental Techniques
  - Offer Repeatable Exercises

Implementation - Sword Tangible

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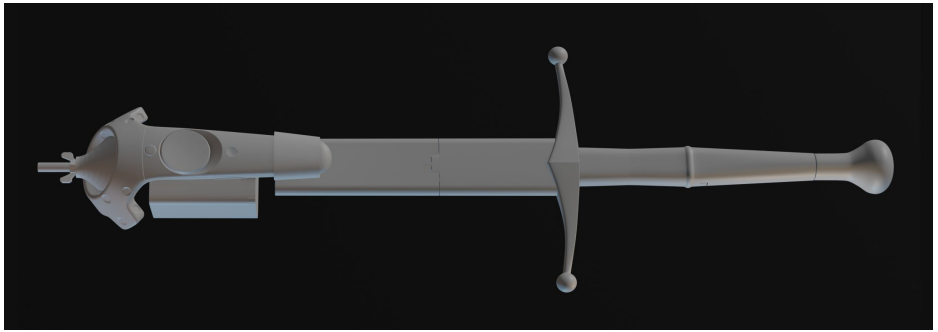
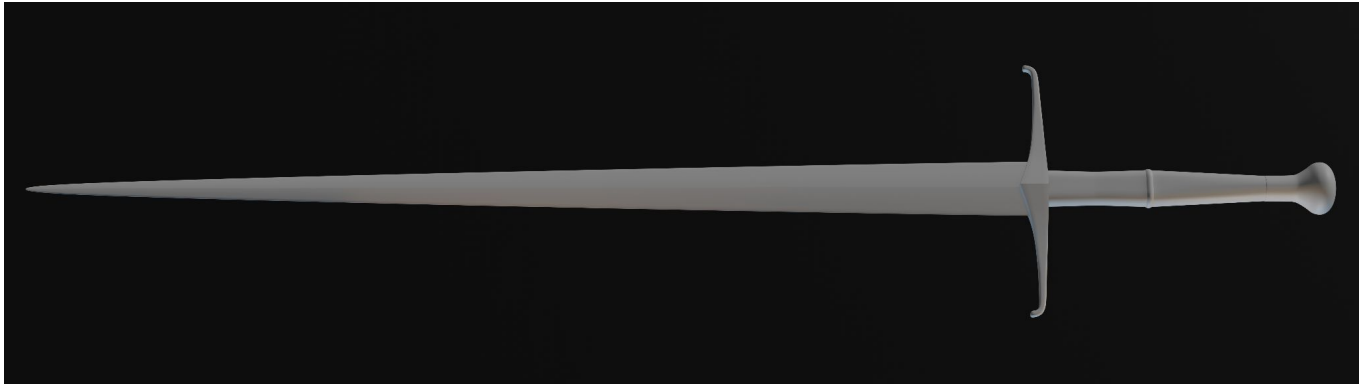
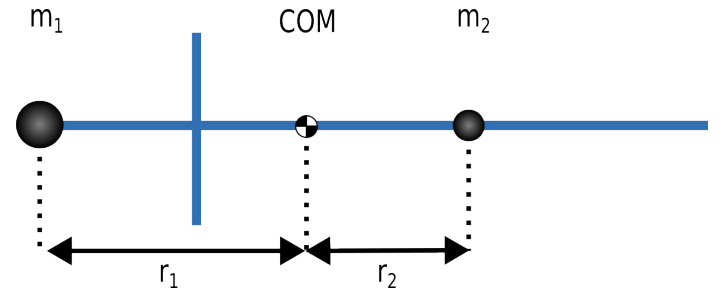
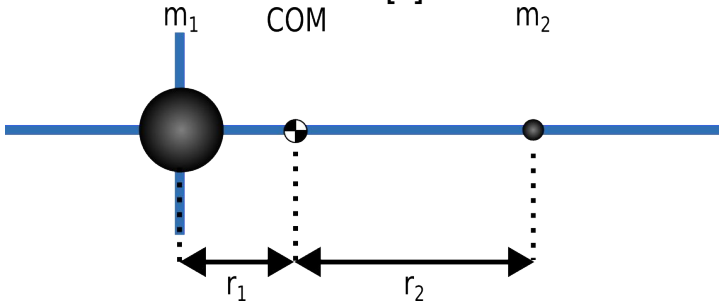




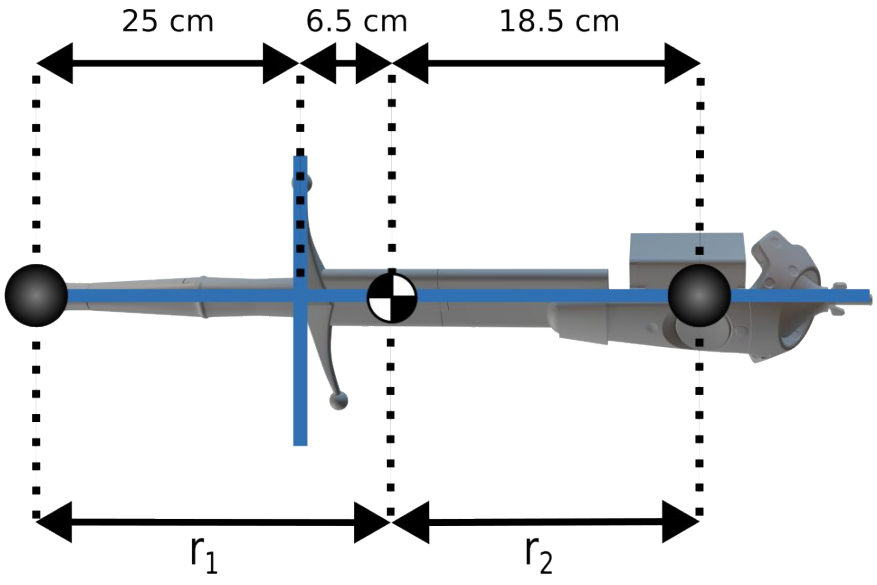
Tangible Physical Properties



Turner [7]



Chevallier [6]



Chosen Approach

Tangible Physical Properties

	Reference*	Theoretical	Measured**
Mass	1353 g	1499 g	1464 g
Balance Point	6.5 cm	6.5 cm	6.2 cm
Moment of Inertia	1329.67 g/cm^2	1319.07 g/cm^2	1381.73 g/cm^2
Radius of Gyration	29.55 cm	30.2 cm	**25.41 cm**

* *Regenyei Talhoffer* (*Oakeshott Type XVa*) training longsword [8]
** Using the *Gravity Pendulum* method, and the *Weapons Dynamics Computer* [9]

Implementation - Choice of Exercise

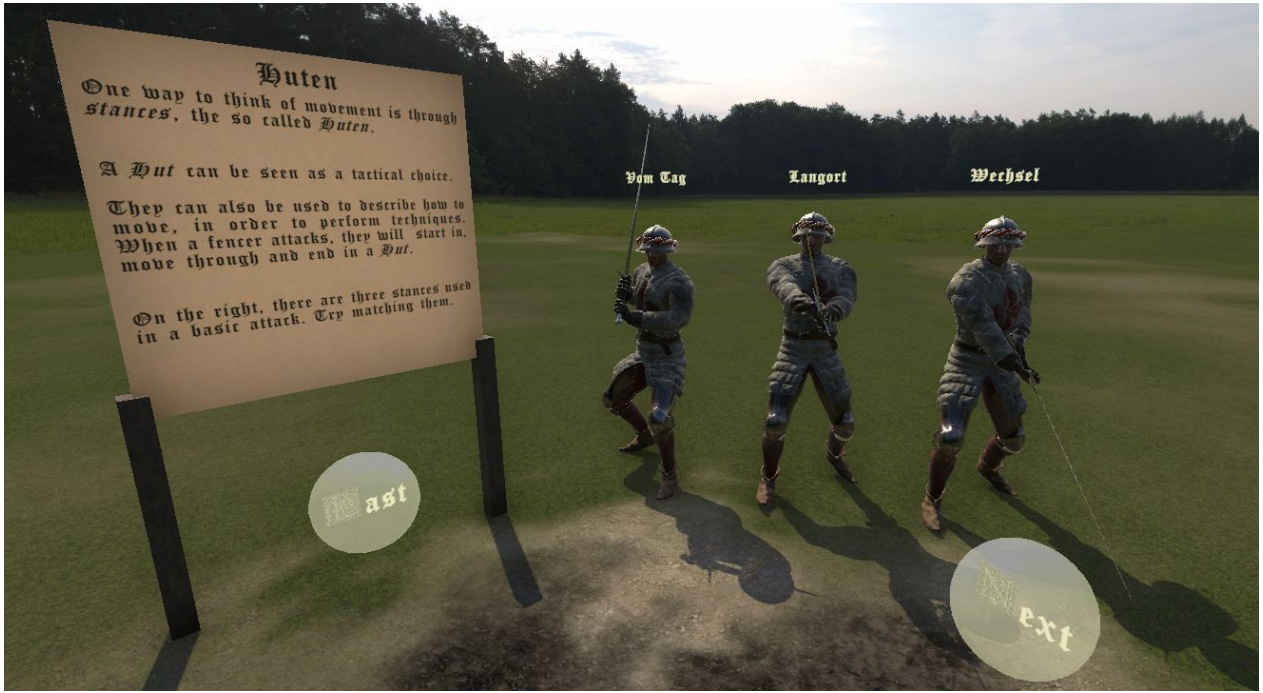
- Sensible Learning Curve
- No Full-Body Tracking
  → Limited Technique Evaluation
- No Haptic Feedback
  → No Blade-on-Blade Contact

→ Limited Number of Possible Exercises

Introductory *Huten* / Attack Exercises

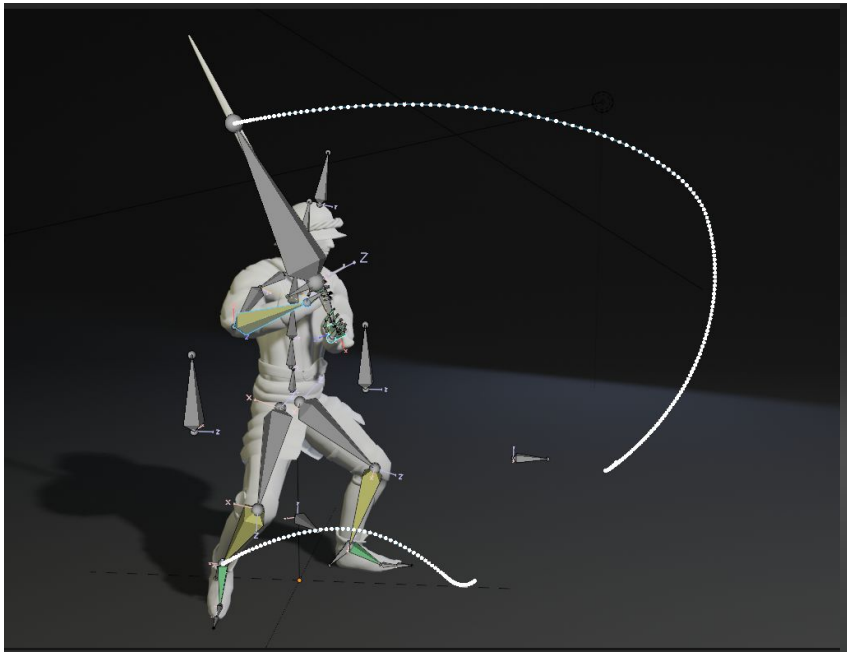
Implementation - Introductory Exercise

- Teaches fundamentals required for further training
- Real-time, spatial, and step-by-step showcase of techniques

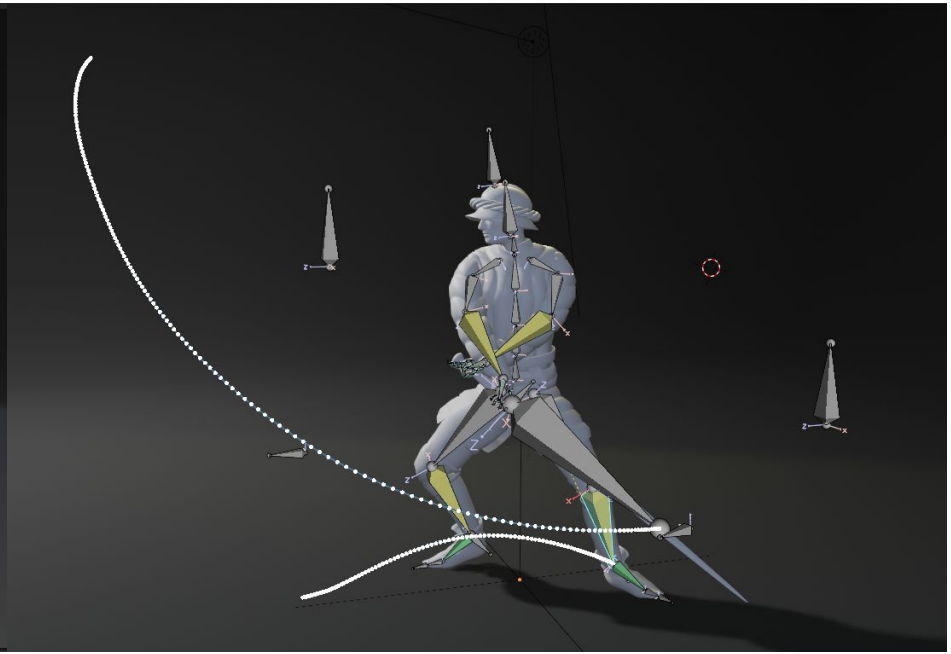


Introductory *Huten* / Attack Exercises

Implementation - Introductory Exercise



Oberhau Animation



Unterhau Animation

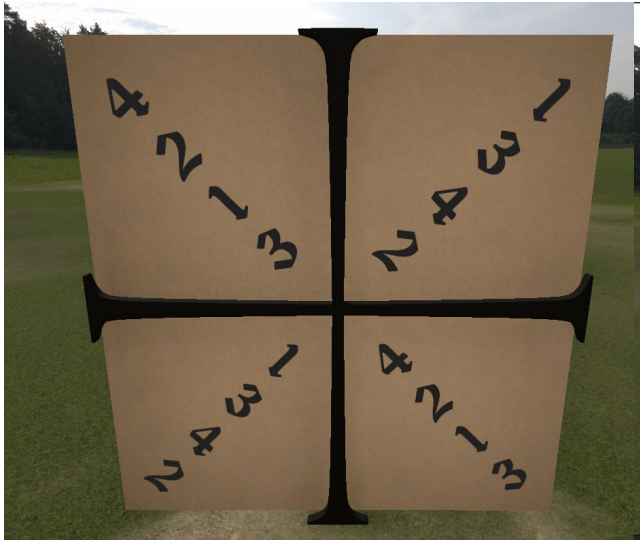
Implementation - Cutting Exercise

- Teaches further aspects of correct cutting technique
- Less overhead than real exercise
- Interactive performance feedback

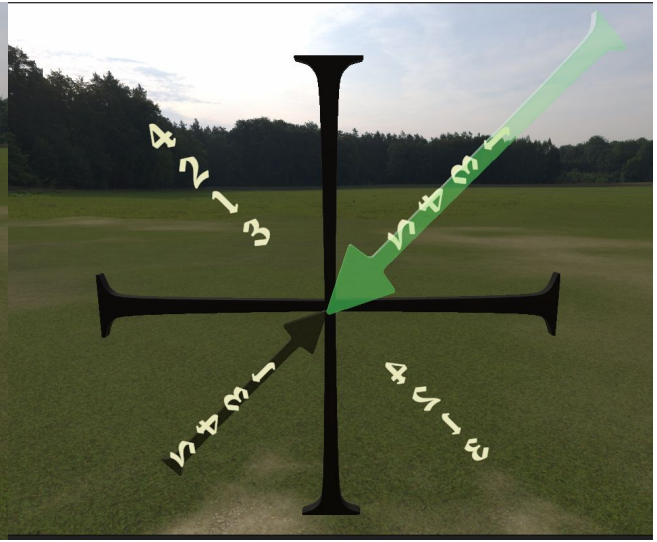
Tatami Cutting Exercise

Implementation - Flow Drill Exercise

- Teaches speed and smooth movement
- Better readability than real exercise
- Interactive performance feedback



Traditional *Meyer Square*



Interactive *Meyer Square*

Evaluation - User Study

- User Study
- Including 4 Subject Matter Experts
- SUS - Questionnaire
- Performance Scores from Quantitative Data
- Experience Scores from Questionnaire
- Compare VR to Traditional by A/B Testing

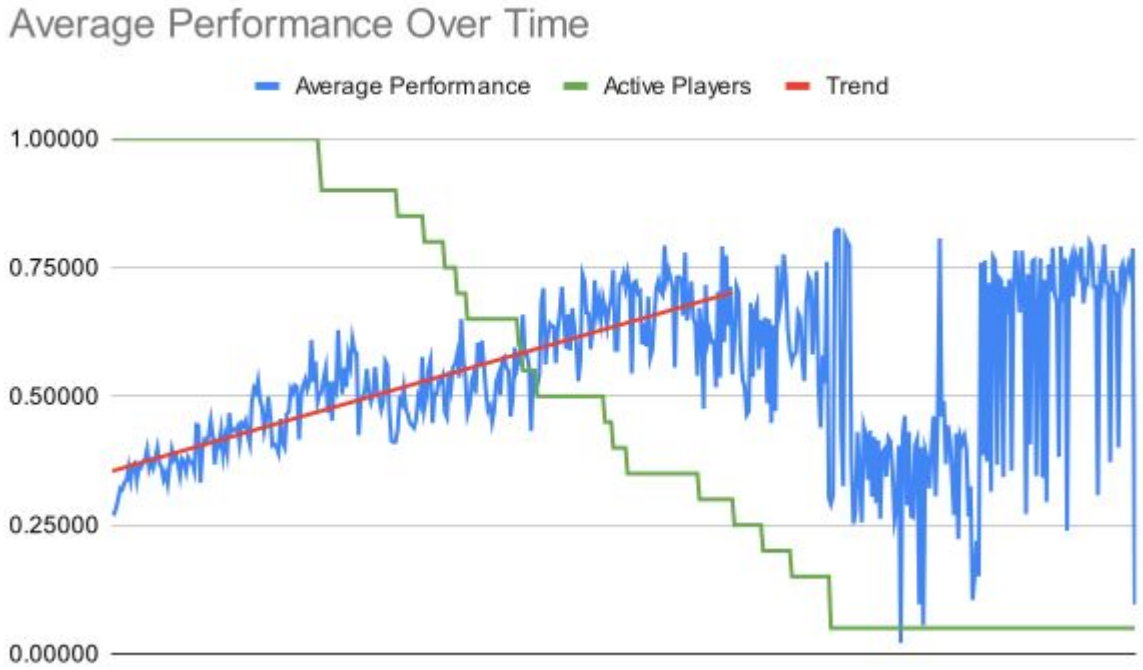
User Study Advertisement

Evaluation - Added Value of VR

Exercise	SUS Score	Meyer Rating	S_{MEYER}	S_{PERF}
Total	**81.15**	0.86	0.91	0.70
Traditional	80.36	0.81	0.84	0.68
Interactive	82.08	0.90	0.98	0.72
Improvement	1.73	0.09	0.14	0.04
Relative Imp.	2.15%	**11.72%**	**16.62%**	5.81%
U-Value*	30.5	36.0	**3.5**	34.5

*U-Value calculated using the Mann-Whitney U-Test, with a target value of 20

Evaluation - Learning Progression



- Gathered Data on Cutting Performance
- Avg. Score Improvement from 0.35 to 0.7

Conclusion & Future Work

Conclusion:

- Successful Proof-of-Concept
- Effective Learning
- Advantages over Traditional Methods
- Subject Matter Experts approve

Future Work:

- Detailed Fencing Technique Evaluation
- Physically Simulated Sword Interaction
- Reactive Opponents

List of References

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