Action Recognition in Virtual Reality

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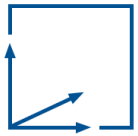

Final: Bachelor Informatics: Games Engineering

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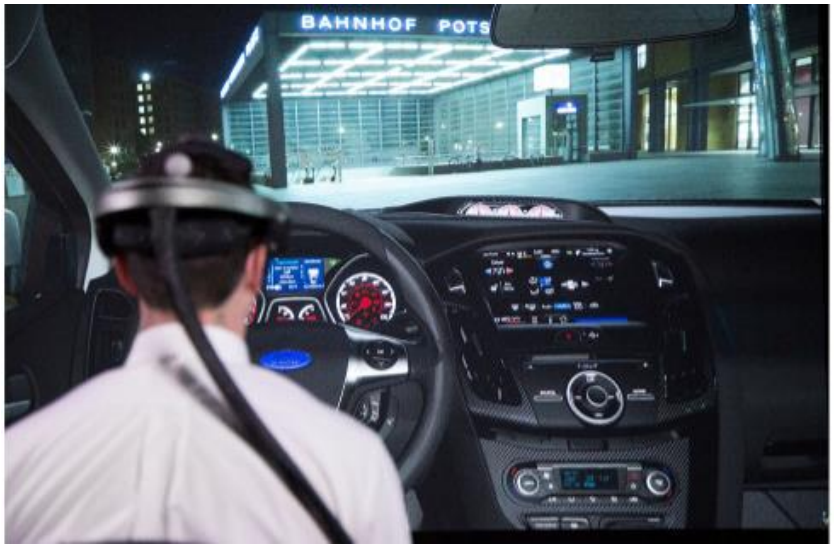
Introduction

- VR becoming more prevalent
- Many industrial sectors use VR
- Common commercial use case: planning
- More advanced headsets (Valve Index)



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Motivation

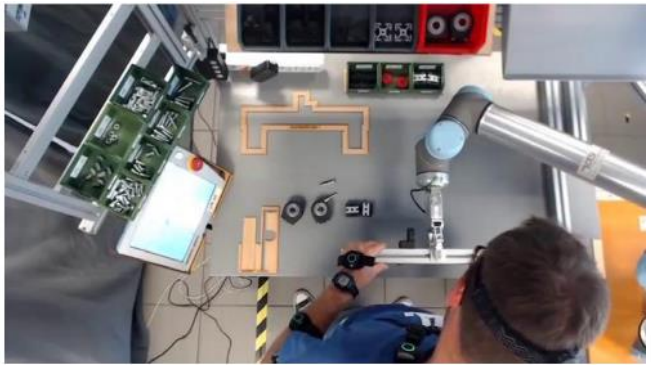
- Dangerous work environments
- Helping workers fulfill jobs without endangering themselves
- Constantly tracking movement in VR leads to skips sometimes

[2]

Existing Solutions / Related Work

- Video/sensor/skeleton-based techniques instead of VR
- Multimodal techniques popular, but require more setup and more computational power
- No research done into solely using a VR headset

[3]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Goals of this Thesis

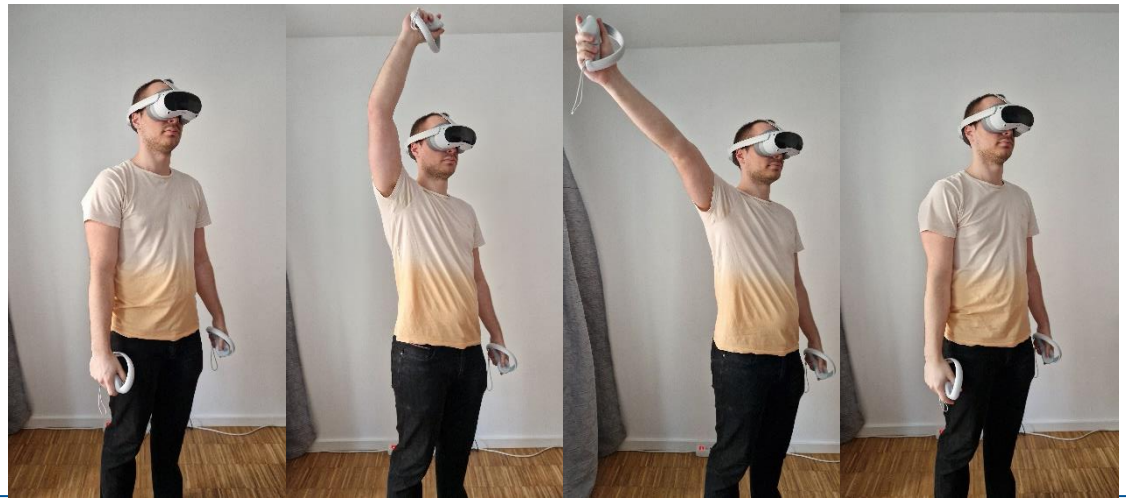
- Create Dataset of 3 everyday motions recorded entirely in VR
- Create and train Neural Network that recognizes the actions performed by the user
- Implement that Network into Unity

Implementation

- Creation of Unity scripts that store the performed action
- Sampling of position, velocity and rotation of the two handheld controllers and HMD
- Saving the information to CSV
- Choice of three everyday actions: throwing, waving and pointing
- Chosen due to similarities and common usage

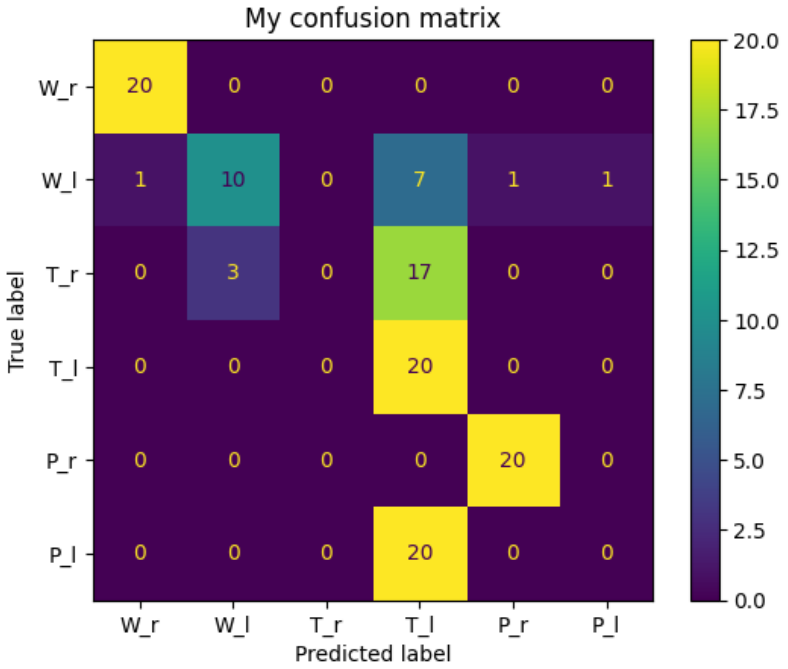
Implementation

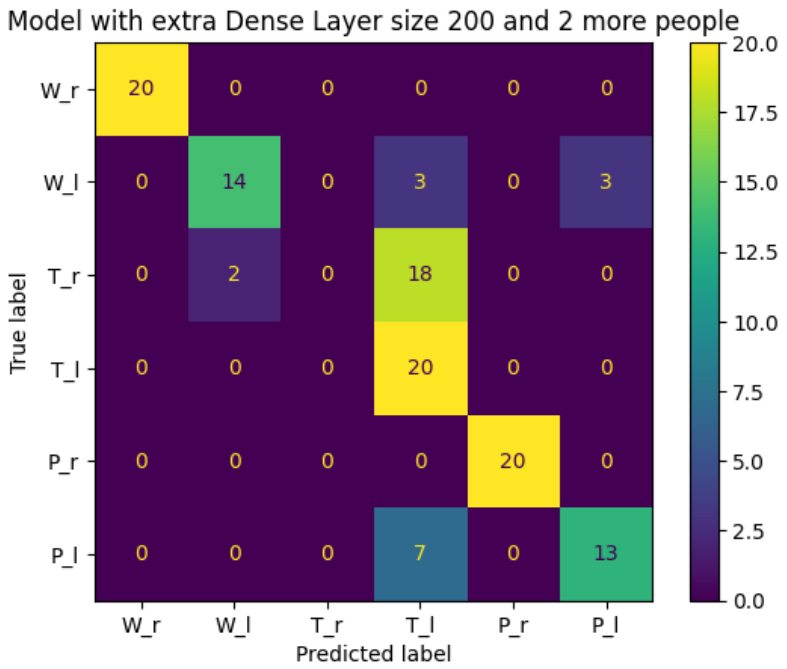
- Creation of a Python notebook using TensorFlow
- Training and testing of Neural Network utilizing an LSTM-layer
- Exporting Neural Network from Python and importing into Unity using Unity Barracuda
- Output of prediction into console



Problems faced

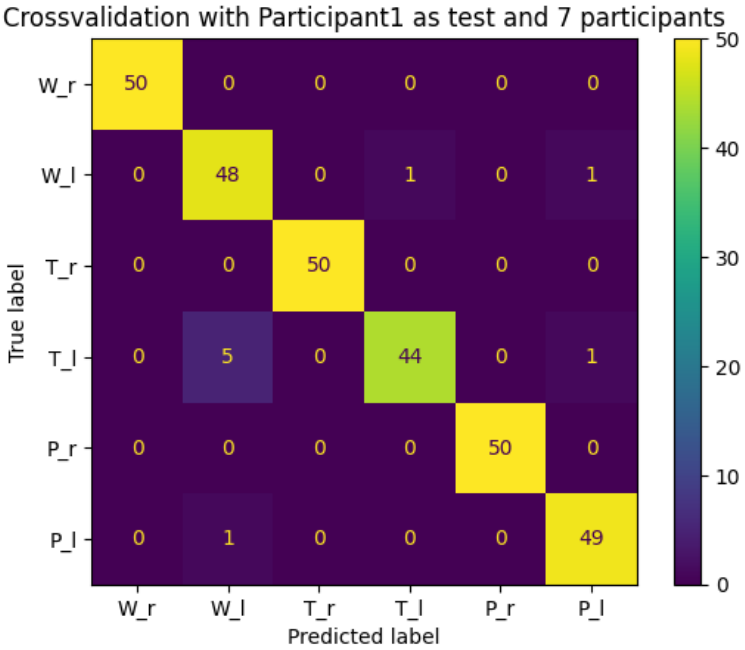
- Low accuracy on small training set
- Multiple tweaks to network with little to no result
- Huge improvement when adding two more people

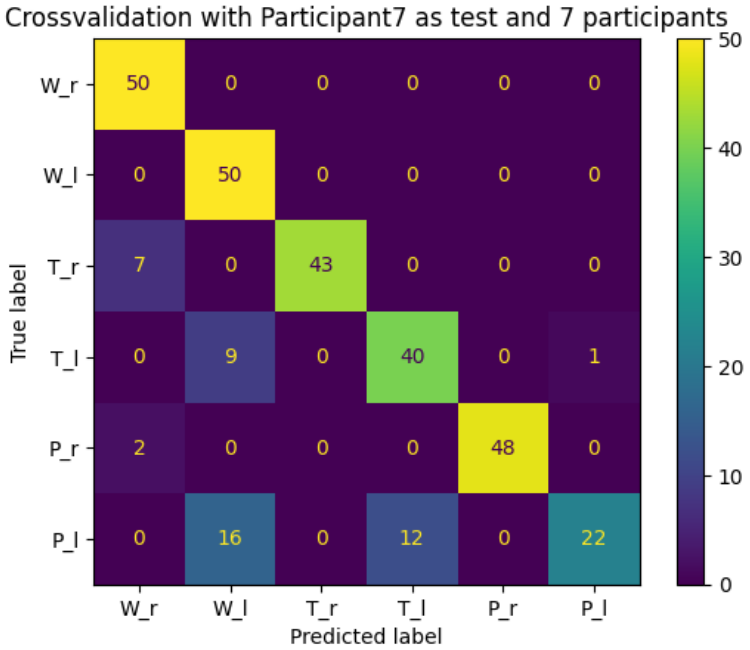




Problems faced

- Increase of dataset size led to big improvement
- Noticing of error in the Training set
- Implementation of ‘leave one subject out’ cross validation
- Still smaller problems with certain actions





Future Work

- Extension of the dataset with more people and actions
- Integration with industrial robots
- Extension of the script with more information provided by more advanced headsets
- Integration in VR communication
- Potential consideration of a multi-modal approach

Conclusion

- For a proof of concept very successful
- More work to be done on accuracy and number of actions, but already very good foundation
- Very good potential to expand on the project

List of References

- [1] L. P. Berg and J. M. Vance. “Industry use of virtual reality in product design and manufacturing: a survey.” In: Virtual reality 21 (2017), pp. 1–17.
- [2] Peter Ray Allison, What does a bomb disposal robot actually do? (https://www.bbc.com/future/article/20160714-what-does-a-bomb-disposal-robot-actually-do) (Accessed 12.05.24)
- [3] C. Liang, J. Lu, and W. Q. Yan. “Human action recognition from digital videos based on deep learning.” In: Proceedings of the 5th International Conference on Control and Computer Vision. 2022, pp. 150–155.
- [4] M. Dallel, V. Havard, Y. Dupuis, and D. Baudry. “Digital twin of an industrial workstation: A novel method of an auto-labeled data generator using virtual reality for human action recognition in the context of human–robot collaboration.” In: Engineering applications of artificial intelligence 118 (2023), p. 105655.