TÉCNICO LISBOA

Engagement Detection with Mixed Reality

Intelligent Systems

MSc in Mechanical Engineering
2025/2026

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My MSc thesis

Figure 1 – HoloLens 2.

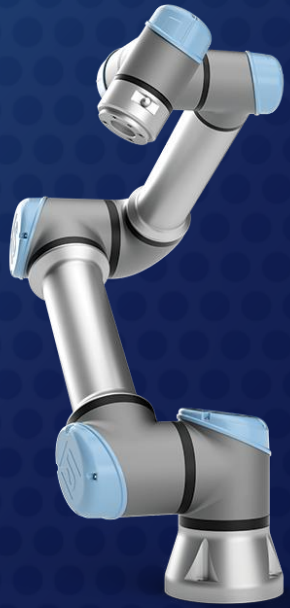
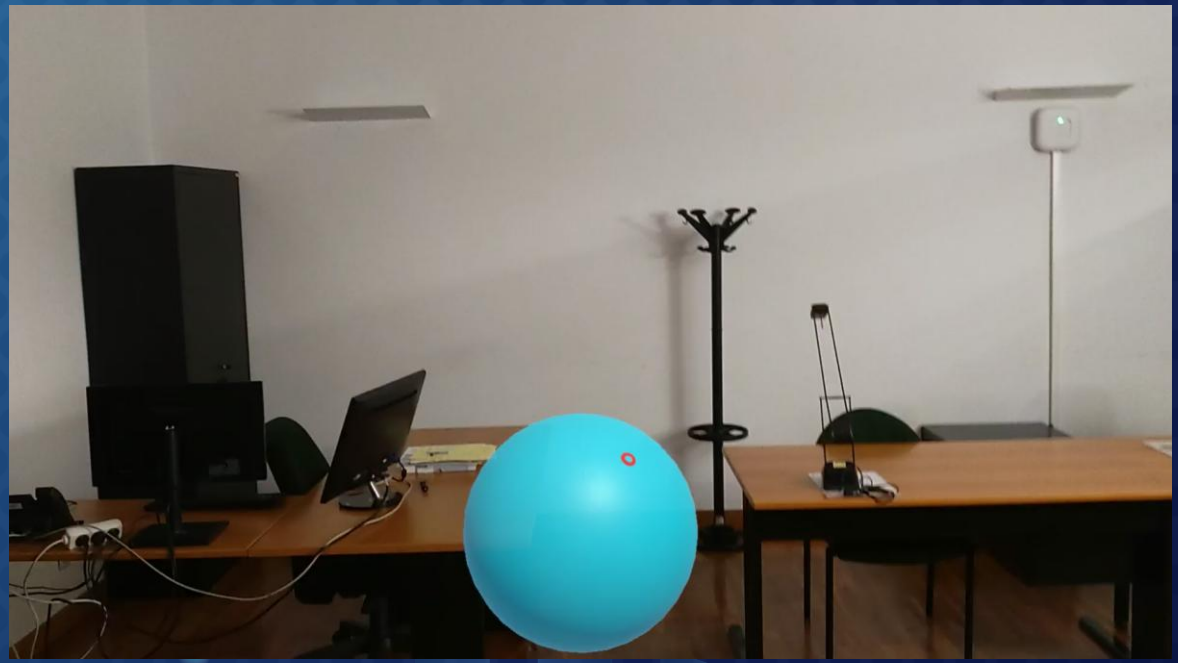


Figure 2 – UR5e robotic arm.

Data Acquisition



Video 1 – Spheres app.

Feature Extraction

Eye Tracking

Blink Rate
Blink Duration

Head Pose

Orientation
Linear Velocity
Angular Velocity

IMU

Accelerometer
Gyroscope
Magnetometer

Preprocessing

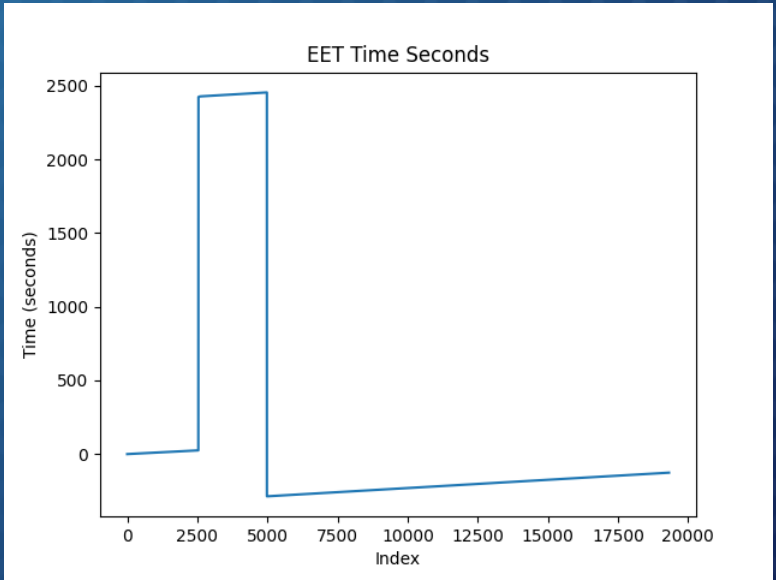


Figure 3 – Inter-synchronization.

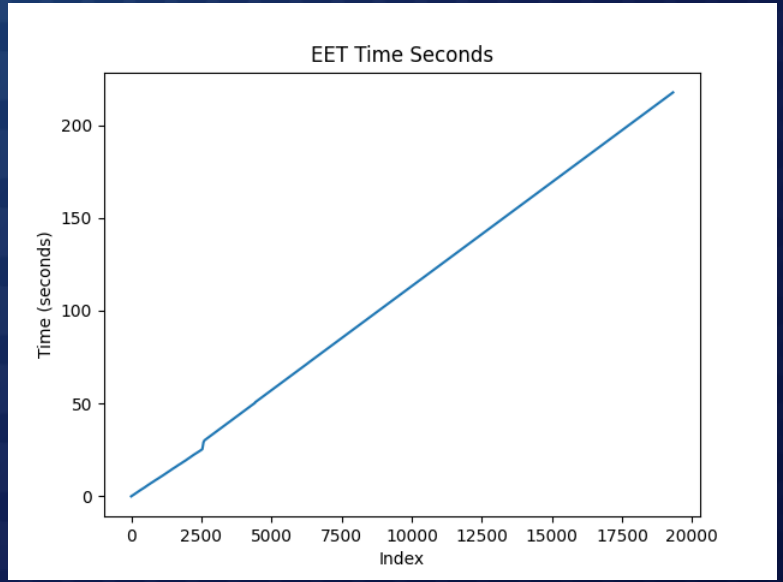


Figure 4 – Intra-synchronization.

Feature Selection

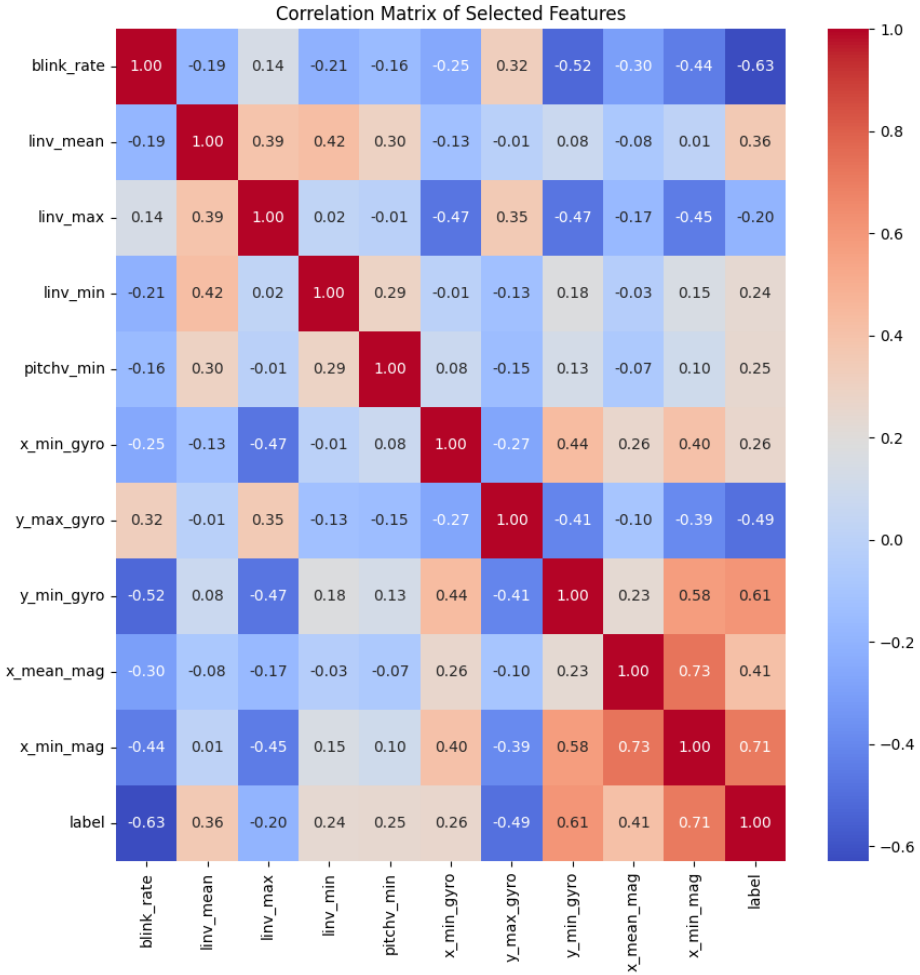


Figure 5 – Correlation matrix of selected features.

Model Architecture

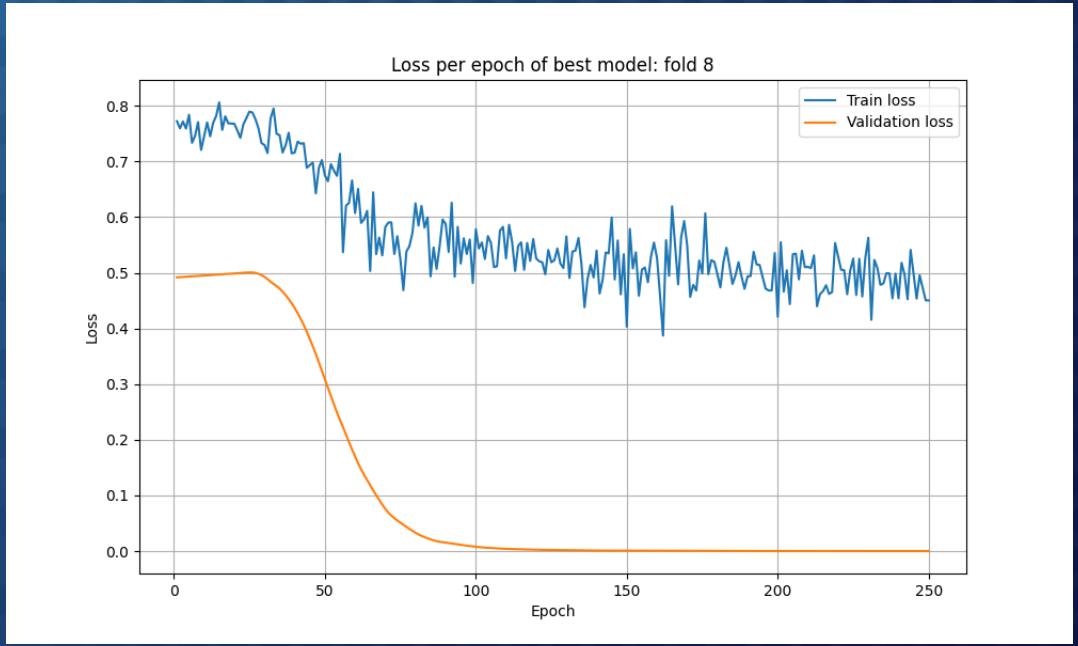


Figure 6 – Loss function per epoch.

Model Performance - NN

	Test	Total
Accuracy	0.952	0.981
F1 Score	0.963	0.984
Precision	1	0.984
Recall	0.929	0.984

Table 1– Evaluation metrics for the NN.

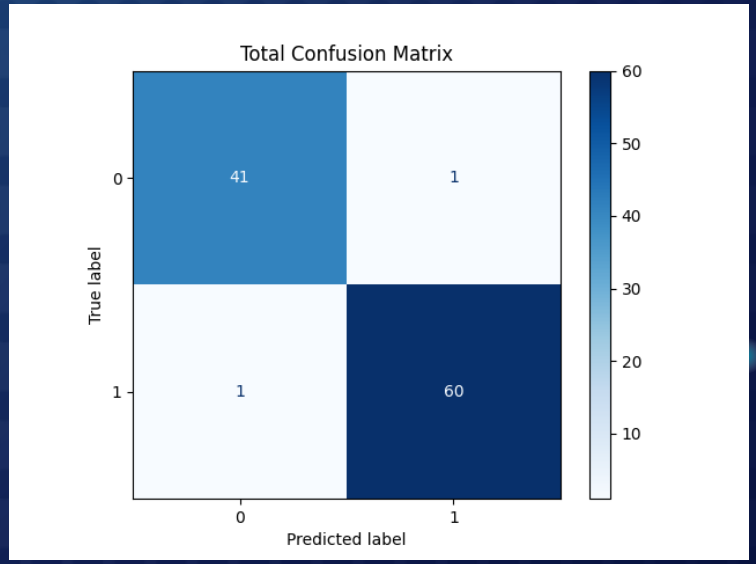


Figure 7 – Confusion matrix for the total dataset with NN.

Model Performance - TSK

	Test	Total
Accuracy	0.952	0.981
F1 Score	0.963	0.984
Precision	1	0.984
Recall	0.929	0.984

Table 2 – Evaluation metrics for the TSK.

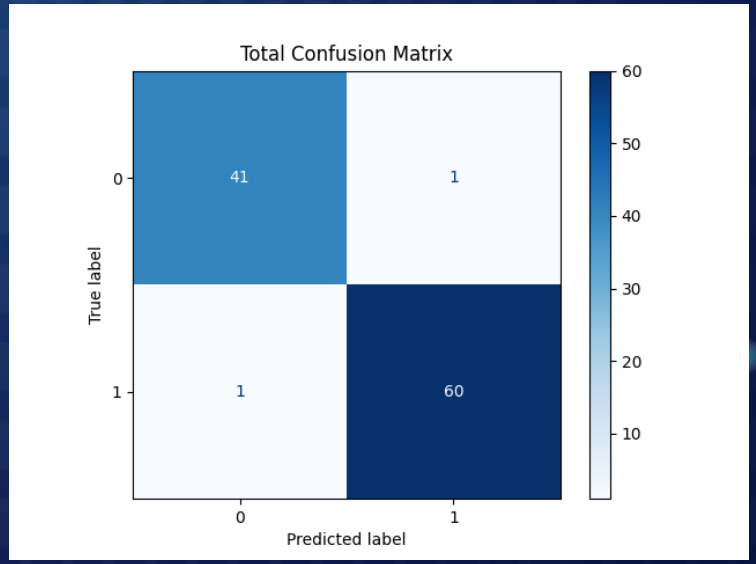


Figure 8 – Confusion matrix for the total dataset with TSK.

Conclusion

- User engagement in MR can be assessed using eye tarcking, body pose and inertial data;
- Blink patterns, head pose and motion features are meaningful indicators of engagement.
- Intelligent algorithms can detect engagement vs. disengagement even with limited data, showing great potential;

Future Work – Second Project

- Dataset expansion with multiple users;
- Improve synchronization;
- Enhance feature extraction (fixations and saccadic movement);
- Optimize models with parameter tuning and complex architectures;
- Implement real-time adaptation.