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HITS
Human-Centered IT Security

ADA-VR: Adaptive Authentication in Virtual Reality

Project Group 2025-2026

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What is Adaptive Authentication?

User authentication is the process of verifying the identity of an individual attempting to access a system

Adaptive authentication (AA) allows the system to adjust verification requirements dynamically for authentication a user depending on **contextual factors** (e.g., location, proximity to devices, user behavior) [1]

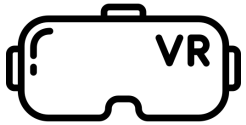
Examples:

- Online Banking: SMS, if login from new device or location unknown **-> adding**
- Apple ID or others: too many wrong login attempts lead to extra verification steps **-> adding**
- Apple Watch: Continuously authenticated when worn (e.g., for Apple Pay) **-> decreasing**
- Samsung Extend Unlock: Keeps phone unlocked on-body detection, trusted places/networks/devices **-> decreasing**

[1] Arias-Cabarcos, Patricia, Christian Krupitzer, and Christian Becker. "A survey on adaptive authentication." *ACM Computing Surveys (CSUR)* 52.4 (2019): 1-30.

Authentication in Virtual Reality

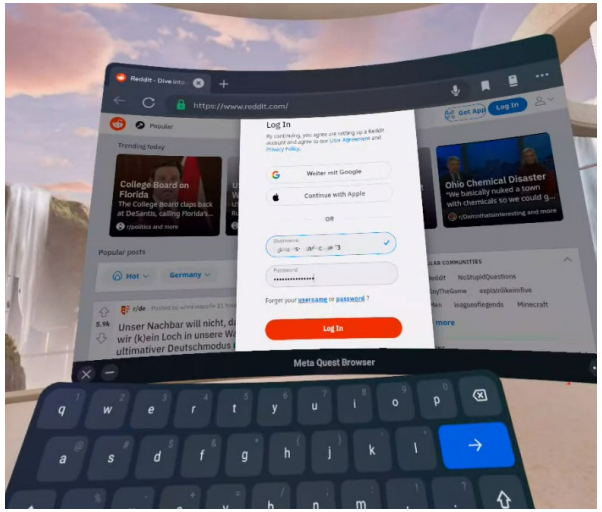
- Standalone devices with own OS -> more than just gaming headsets
- VR used in different **domains**: Education, Industry, Health care, Military, Productivity
- Need **authentication** for
  - Preventing unauthorized access to virtual environment, especially multi-user environments/devices
  - Protecting user identity and personal data
  - In-App purchases, (web-) apps…



Passwords in VR

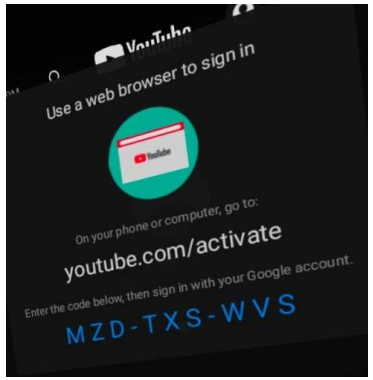
Predominant authentication method in VR

Input method: controller and virtual keyboard



Issues[1,2]:

- Slow typing
- Difficult
- Unpleasant

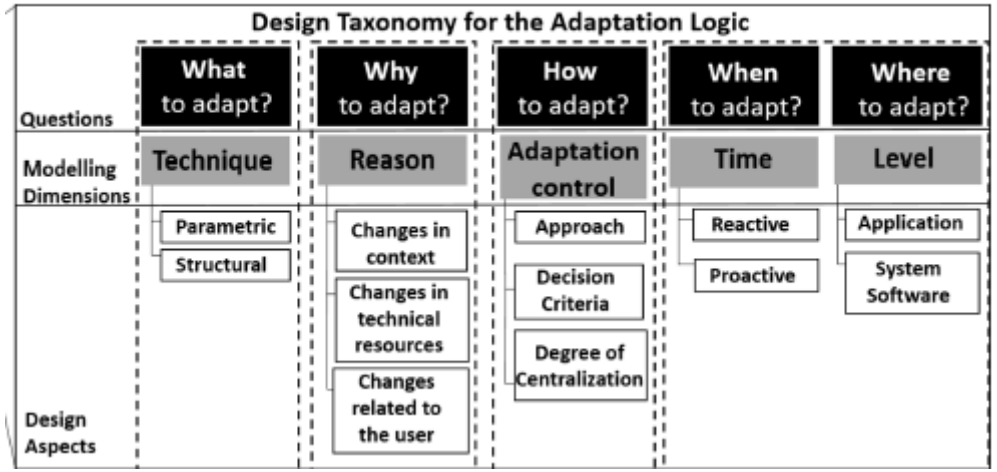


Authentication is user's second task!
We still want a secure environment while preserving user experience and immersion!

[1] Stephenson, Sophie, et al. "Sok: Authentication in augmented and virtual reality." *2022 IEEE Symposium on Security and Privacy (SP)*. IEEE, 2022.
[2] Kablo, Emiram, et al. "The (Un) suitability of Passwords and Password Managers in Virtual Reality." *arXiv preprint arXiv:2503.18550* (2025).

Adaptive Authentication in VR?

- Introducing (additional) security layers makes authentication **more secure** against attacks but **may affect usability**
- Schemes can deactivate additional (behavioral biometric) security layers in a safe context (e.g., home)[1]



Design taxonomy for adaptation logic in architecture for distributed AA systems[2,3]

[1] Mathis, Florian, Hassan Ismail Fawaz, and Mohamed Khamis. "Knowledge-driven biometric authentication in virtual reality." *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. 2020.
[2] Arias-Cabarcos, Patricia, Christian Krupitzer, and Christian Becker. "A survey on adaptive authentication." *ACM Computing Surveys (CSUR)* 52.4 (2019): 1-30.
[3] Krupitzer, Christian, et al. "A survey on engineering approaches for self-adaptive systems." *Pervasive and Mobile Computing* 17 (2015): 184-206.

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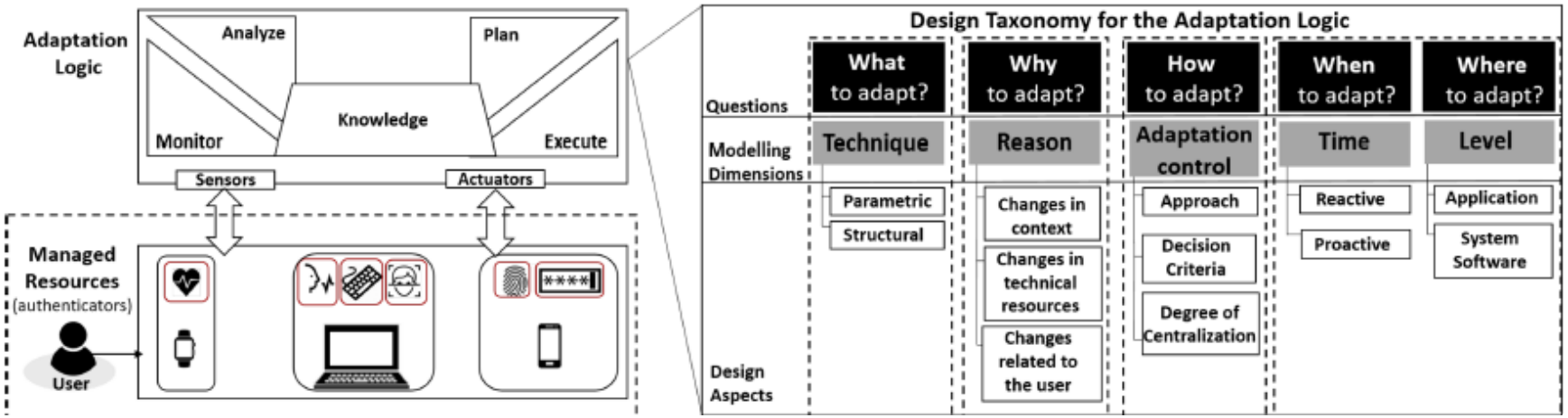
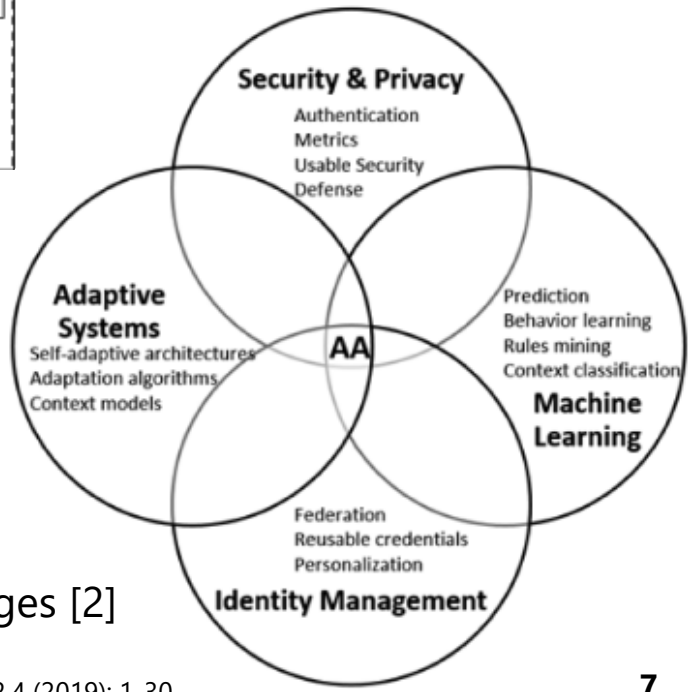
First Phase: Familiarization (first half of WS 25/26)

State of the Art/Related Work: AA



MAPE-K architecture and design taxonomy for adaptation logic [2,3]

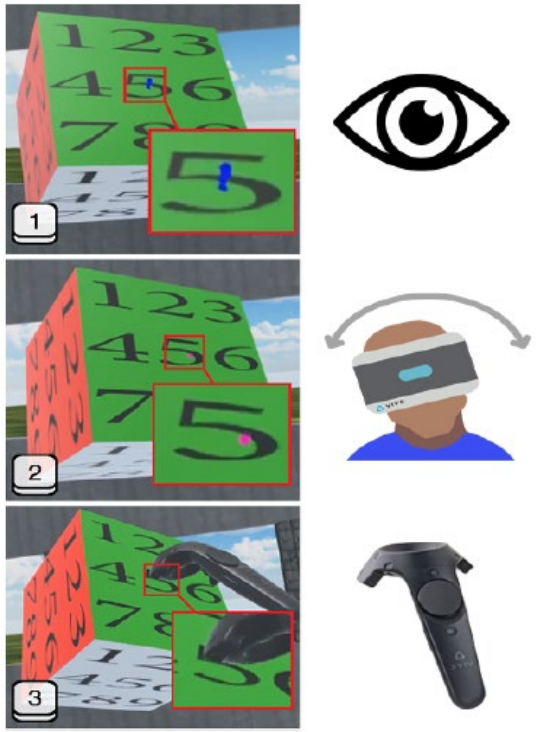


Interdisciplinary research areas with challenges [2]

[2] Arias-Cabarcos, Patricia, Christian Krupitzer, and Christian Becker. "A survey on adaptive authentication." *ACM Computing Surveys (CSUR)* 52.4 (2019): 1-30.
[3] Krupitzer, Christian, et al. "A survey on engineering approaches for self-adaptive systems." *Pervasive and Mobile Computing* 17 (2015): 184-206.

VR Authentication in Research

RubikAuth[4] /RubikBiom[5] by Mathis et al.



PassGlobe by Länge et al.[6]

Passimoji, C-Lock, Randomized PIN[7]

[4] Mathis, Florian, et al. "Rubikauth: Fast and secure authentication in virtual reality." *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. 2020.
[5] Mathis, Florian, Hassan Ismail Fawaz, and Mohamed Khamis. "Knowledge-driven biometric authentication in virtual reality." *Extended Abstracts of the 2020 CHI Conference on Human Factors*
[6] Länge, Tobias, et al. "PassGlobe: Ein Shoulder-Surfing resistentes Authentifizierungsverfahren für Virtual Reality Head-Mounted Displays." (2022).
[7] Länge, Tobias, et al. "Vision: Towards Fully Shoulder-Surfing Resistant and Usable Authentication for Virtual Reality." (2024).

Outcome: Proposal

- How to create an adaptive authentication system in VR
- Use of MAPE-K Architecture and answer questions of design taxonomy
  - What contextual factors can be used, when to execute, what to protect and so on
- Considering privacy aspects[1]

- Summarized in a document

[1] Kablo, Emiram, et al. "PrivaCI in VR: Exploring Perceptions and Acceptability of Data Sharing in Virtual Reality Through Contextual Integrity."

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Second Phase: Prototyping and Evaluation (second half of WS 25/26 + SS 26)

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Implementation

- Prototype of an AA system in Virtual Reality
- Using Unity, C# -> Programming skills necessary
- ML skills eventually for biometrics/behavioral data

What we offer

- Lab to work in
- VR devices, currently: Meta Quest Pro & 2
  - Budget for more/different devices
- PC with powerful GPU in the lab

Outcome

- Product and (User-)Testing Report
- **Goal**: Secure and usable environment in Virtual Reality through AA

Questions?

Ask after these presentations ☺

Contact Emiram: ekablo@mail.upb.de

Visit our website for information: cs.uni-paderborn.de/its (> Teaching > ADA-VR)