GazeLock: Gaze- and Lock Pattern-Based Authentication

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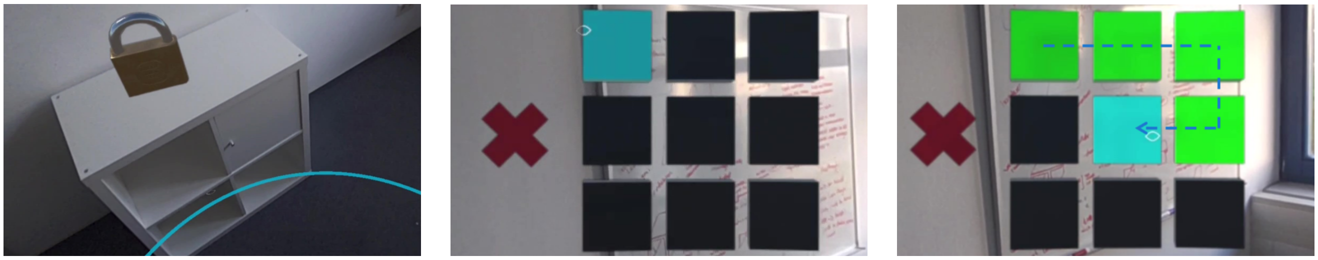

(a) The user begins authentication by focusing on the virtual lock icon.

(b) The lock pattern appears. Gaze-based passcode entry can start from any point.

(c) Successful entry of the correct passcode unlocks the smart device.

Figure 1: GazeLock overview: (a) gaze at the lock icon, (b) input passcode pattern, (c) unlock device.

Abstract

Password entry is common authentication approach in Extended Reality (XR) applications for its simplicity and familiarity, but it faces challenges in public and dynamic environments due to its cumbersome nature and susceptibility to observation attacks. Manual password input can be disruptive and prone to theft through shoulder surfing or surveillance. While alternative knowledge-based approaches exist, they often require complex physical gestures and are impractical for frequent public use. We present GazeLock, an eye-tracking and lock pattern-based authentication method. This method aims to provide an easy-to-learn and efficient alternative by leveraging familiar lock patterns operated through gaze. It ensures resilience to external observation, as physical interaction is unnecessary and eyes are obscured by the headset. Its hands-free, discreet nature makes it suitable for secure public use. We demonstrate this method by simulating the unlocking of a smart lock via an XR headset, showcasing its potential applications and benefits in real-world scenarios.

CCS Concepts

• **Human-centered computing → Mixed / augmented reality**; *Interaction techniques*; • **Security and privacy → Authentication**.

Keywords

Extended Reality (XR), Gaze-based Interaction, Authentication, Eye Tracking

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1 Introduction

As XR technologies continue to advance and integrate into everyday life, the need for secure and efficient authentication methods becomes increasingly critical. Traditional password entry, though simple and familiar, is vulnerable in public and dynamic XR settings as it is susceptible to observation attacks such as shoulder surfing and surveillance. Additionally, XR headsets lack conventional input methods, making manual password entry cumbersome, leading users to choose weaker passwords and disrupting immersive XR experiences [7].

Alternative knowledge-based approaches, such as novel PIN entry methods, graphical passwords, or gesture-based authentication, offer potential solutions but also come with their own set

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of challenges. Novel PIN entry methods [5] may be complex and difficult to learn, creating a barrier to user adaptation. Graphical passwords [8] can be more secure against brute force attacks but are still vulnerable to observation if the gestures are visible to others. Gesture-based methods [2] demand significant physical effort and can draw unwanted attention in public spaces.

Integrating eye trackers into XR headsets presents a promising solution to these issues [4]. Eye-tracking technology allows for hands-free, secure, and efficient authentication, seamlessly aligning with the immersive nature of XR environments. By leveraging natural gaze patterns of users, eye trackers can facilitate authentication without the need for additional devices or cumbersome input methods. Furthermore, they mitigate the risk of observation attacks due to the lack of visible physical gestures.

In this work, we introduce GazeLock, a gaze-based interaction method for password entry in XR applications. It addresses traditional manual password input challenges in public and dynamic environments by using eye-tracking technology and familiar lock patterns for a hands-free, easy-to-learn, and secure authentication process. We showcase its potential by demonstrating the unlocking of a smart lock via an XR headset.

2 GazeLock

Interaction with GazeLock begins when the user looks at the virtual lock icon above the smart device, as shown in Figure 1a. To ensure intentional engagement and prevent accidental activation, the user needs to maintain their focus for 1 second to start the authentication process.

Subsequently, a 3x3 grid of dots, similar to an Android Lock Pattern, appears in the user's field of view (Figure 1b). Passcode entry can begin from any dot, with the initial selection requiring a 1-second dwell time to avoid unintentional input, while subsequent selections require a shorter dwell time of 0.2 seconds. The user selects dots sequentially using their gaze, forming a pattern that serves as the password. During this process, visual feedback is provided: selected dots turn green, and hovered dots turn blue, guiding the user through the entry without the need for physical interaction, as shown in Figure 1c.

When the correct pattern is entered, a green tick and an animation of the virtual lock unlocking are displayed, confirming successful authentication and granting access to the smart device. To accommodate mistakes, GazeLock allows users to cancel a login attempt by focusing on a red cancel cross next to the grid, enabling the user to restart the authentication process. In addition, GazeLock supports field skipping, allowing users to skip over dots while the system automatically fills in the skipped fields.

We implemented GazeLock in Unity using the XR Interaction Toolkit. For our demonstration, we used the HTC Vive XR Elite headset[1] and the MQTT protocol to communicate with a smart locker controlled by an ESP32 microcontroller.[2] Upon successful authentication, a message is sent to the microcontroller to unlock the locker, and in case of communication failure, the locker automatically re-locks to prevent unauthorized access.

3 Conclusion

This work-in-progress presents an authentication method for XR environments using eye-tracking and lock pattern. By combining eye-tracking with intuitive lock patterns, GazeLock aims to provide an easy-to-learn alternative to manual password entry that is resilient to external observation.

Despite its potential benefits, GazeLock relies on precise eye-tracking. While the calibration is an inherent requirement of the headset's design, it might need to be repeated if the headset shifts on the user's head. Thus, exploring methods to reduce this need, such as offset calculation [1], could enhance user experience. Additionally, prolonged use of eye-tracking for interactions can lead to user fatigue, as maintaining focus on specific points for the required dwell times can be straining over time. This could be mitigated by introducing subtle multi-modal interaction methods, such as the gaze-and-pinch interaction [6]. Introducing pinch to confirm selection would also address the Midas Touch Problem [3], eliminating fixed dwell times and may reduce the error rates and entry times.

Future work will involve conducting a user study to validate the usability and efficiency of GazeLock. We will also explore enhancements such as offset calculation and other interaction designs. Furthermore, we will investigate its potential applications in interactive public displays [1].

Acknowledgments

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