Holo-Box: Level-of-Detail Glanceable Interfaces for Augmented Reality

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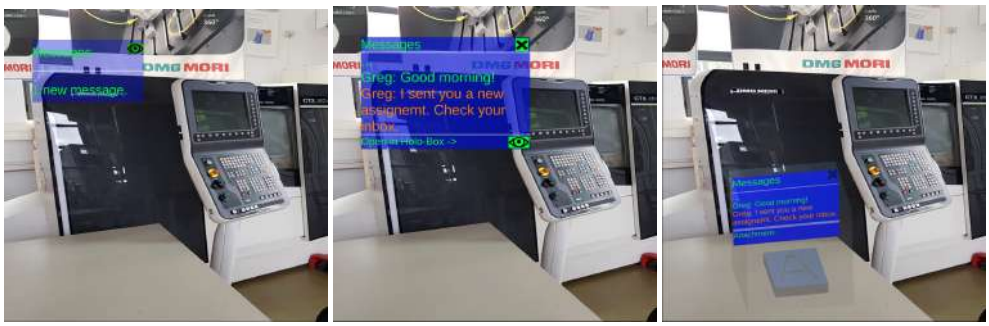

Figure 1: From left to right: The Holo-Box interface's three Levels of Detail, shown in the context of a machine shop. Simple Glanceable (SG-level 1), Detailed Glanceable (DG-level 2) and the Interactive Holo-box (HB-level 3).

ABSTRACT

Glanceable interfaces are Augmented Reality (AR) User Interfaces (UIs) for information retrieval "at a glance" relying on eye gaze for implicit input. While they provide rapid information retrieval, they often occlude a large part of the real-world. This is compounded as the amount of virtual information increases. Interacting with complex glanceable interfaces often results in unintentional eye gaze interaction and selections due to the *Midas Touch* problem. In this work, we present Holo-box, an innovative AR UI design that combines 2D compact glanceable interfaces with 3D virtual "Holo-boxes". We can utilize the glanceable 2D interface to provide compact information at a glance while using Holo-box for explicit input such as hand tracking activated when necessary, surpassing the Midas Touch problem and resulting in Level-of-Detail(LOD) for AR glanceable UIs. We test our proposed system inside a real-world machine shop to provide on-demand virtual information while minimizing unintentional real-world occlusion.

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1 INTRODUCTION

AR Head-Mounted Displays (HMDs) have limited Field of View (FOV) [Koulieris et al. 2019]. Ideally, virtual content could be selectively presented only when needed or triggered by users' gaze [Drakopoulos et al. 2021] or by user's distance [DiVerdi et al. 2004]. This approach minimizes information overload and visual clutter [McNamara et al. 2019]. Eye-tracking can pin-point users' gaze enabling hands-free interaction [Pfeuffer et al. 2021]. Glanceable interfaces employ eye gaze to rapidly retrieve virtual information without the need for direct or complicated input [Lu et al. 2020]. It is challenging for an AR system to determine whether users' gaze is directed on the real or virtual world and how it can shift between them in a seamless manner [Buxton 1995]. Designing glanceable AR interfaces at various Levels of Detail (LODs), displayed interchangeably serves the presentation of either compact or detailed information as needed [Lindlbauer et al. 2019]. While glanceable interfaces provide rapid information retrieval at a glance and implicit interaction using gaze, they also suffer from (i) limited scalability as the amount of augmented information increases [Lu et al. 2020] (ii) problems when viewing augmented content at an angle [Lindlbauer et al. 2019] (iii) unintentional interactions using gaze known as the Midas Touch problem [Jacob 1990].

In this preliminary work, we propose an innovative, gaze-activated, 2D glanceable UI design providing compact information, bundled with a 3D interactive interface, in a three Level-Of-Detail (LOD) architecture for AR UIs named 'Holo-box' (Figure 1). The 2D glanceable interface is always on and fixed to a location on the user's viewport, presenting compact information expanded at will with a glance, to reveal additional information. Using the Holo-box architecture we achieve progressive UI and information placement in AR according to context, avoiding real-world obstruction and the Midas Touch problem, using explicit input such as gestures.

We apply our novel hybrid Glanceable UI design to a real-world machine shop case study. In Industry 4.0 manufacturing, AR is employed by human operators of machinery using AR to access remote information on demand instead of using manual control units [Oztemel and Gursev 2020]. Safety concerns that emerge from current AR systems often include occlusion of the real-world [Qian et al. 2018], [Zhu et al. 2015]. Current VR simulations are not applicable to real-world training/logistics [Zhao et al. 2020].

2 IMPLEMENTATION

We analyze our 3-LOD interface architecture named **Holo-Box** and its use in a machine shop based on the Magic Leap One AR HMD.

2.1 3-LOD architecture

Holo-box employs three LODs, e.g., Simple Glanceable (SG), Detailed Glanceable (DG) and Holo-boxes (HB), each LOD revealing information of varying levels of real-world occlusion. SG and DG are 2D display-fixed that use eye gaze interaction. The HB is a 3D interface that persists in the physical space and may receive direct input using hand and gesture tracking.

- **Level 1: Simple Glanceable** interfaces (SG) (Fig.1 left), are visible by default while the user is focused on the real world, are compact and semi-transparent. Their purpose is to alert users to changes of the virtual content. Interaction is initiated by gaze-activated virtual buttons, using a small gaze-dwell delay. This short gaze-dwell initiates a transition to a Detailed Glanceable (DG) interface.
- **Level 2: Detailed Glanceable** interfaces (DG) (Fig.1 center), provide more complex information compared to SG UIs such as lines of text or graphs. DG UIs are less transparent than SG. DG elements do not cover the entire FOV allowing for real-world spatial awareness. Using gaze-dwell as input, the user can revert back to the SG interface or progress to the more detailed Holo-box mode.
- **Level 3: Holo-boxes** (HB) (Fig.1 right), are 3D interfaces summoned at will or established at predetermined locations. The HB is an isolated space where the user can freely interact with virtual content using direct input without environmental occlusion or safety hazards. HB interfaces include both 2D and 3D content scaled to the size of the HB itself and to the user's available space.

2.2 Machine Shop AR

We apply the presented UI architecture in a machine shop. Users wear a Magic Leap while operating milling or turning machinery accessing virtual content through the Holo-box's UI, including SG and DG UIs. Augmented content may vary from notifications to visualizing complex 3D objects for manufacturing. Virtual interfaces use the presented three-tier non-intrusive LOD architecture while the user's focus is on the real world. Milling and turning tasks are presented gamified as "missions" consisting of a 3D or 2D object representation to manufacture as well as a textual description of the manufacturing process [Daskalogrigorakis et al. 2021]. By using Holo-box's architecture we can present a mission as follows:

- **Level 1: SG** Notification that a new mission is available which may pop up at any time while the user is working.
- **Level 2: DG** Simple textual description of the request which is shown after pressing a button on the SG interface.
- **Level 3: HB** Detailed textual description of the request based on an interactable 3D model of the requested object to manufacture, shown on demand after pressing a button on the DG interface at a Holo-box placed on the 3D space.

3 CONCLUSION

We propose Holo-Box, a three-tiered LOD UI for AR activated by a glanceable UI. Holo-box's hybrid UI provides glanceable information (SG, DG) and 3D interfaces (HB) employing gestures and hand tracking when needed. Holo-box is tested in a machine shop, visualising virtual content seamlessly, minimising real world occlusion and unintentional gaze. Gaze accuracy is currently unstable based on lighting conditions and quality of environmental scanning.

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