Augmented Reality Order Picking Aid for Foreign Workers in Warehouses

Ahmad Albawaneh, Shruthi Venkatesha Murthy, Goutam Singla, Jiang Wu Industrial and Systems Engineering Department, Oakland University

Objective: This study aims to evaluate an AR HMD system against traditional methods, focusing on its potential to aid non-native English-speaking warehouse workers and boost efficiency and accuracy in picking tasks. Our goal is to ascertain whether an AR aid system, utilizing universal and conformal design principles, can yield superior results in user performance, usability, and situational awareness compared to written instructions.

Background: In warehouse workers utilize written instructions, which can be challenging for those less language proficient. The integration of augmented reality (AR) head- mounted displays (HMDs) may enhance accuracy and efficiency (Matsumoto et al., 2019). In order to fully comprehend the potential and limitations of HMDs, further research is necessary, targeting effective strategies for implementation and optimal AR user interface (UI) design.
Method: We identified the language-related challenges faced by foreign workers through interviews. Guided by these insights, we designed an AR solution with universal symbols and intuitive interactions. The AR solution was prototyped using Microsoft HoloLens 2. To evaluate our proposal, we conducted a within-subject experiment (n = 17) in a controlled laboratory environment, comparing this AR headset instruction with traditional written instructions. We employed the situation awareness, usability along with performance measures, to assess the effectiveness of our proposal.

Results: Our study indicated no significant difference in task completion time between traditional and AR headset instructions. However, AR significantly reduced package identification time (M=6.89, SE=0.40 vs. M=10.15, SE=0.61). Moreover, people with the AR instructions had no errors while with the traditional written instructions had a total of 2 errors. The proposed AR aid also resulted in enhanced worker situation awareness by allowing them not to divide their attention across job instructions and the dynamic warehouse environment (M=2.41, SE=0.24 vs. M=3.70, SE=0.35). The AR headset was perceived as easier to use (M=4.35, SE=0.16 vs. M=3.35, SE=0.17) and better integrated various functions (M=3.94, SE=0.16 vs. M=2.70, SE=0.19), despite some participants reported a need for technical assistance.
Conclusion: The human-subject experiment demonstrates that the proposed AR aid system is effective in eliminating errors, improving ease of use, and enhancing situation awareness of foreign workers in warehouses. This study also underscores the importance of a user-centered approach in leveraging technology for users in diverse contexts.

Impact and Contribution: Our proposal holds promising prospects beyond the scope of this study. Its potential extends to various safety-critical domains, including transportation, construction, and military operations, where operators' awareness of the dynamic environment is crucial (Kim et al., 2020). Additionally, our findings have resulted in a UI design guideline for

AR headsets. This guideline emphasizes the need to consider the headset's field of view during the UI design process, ensuring that all UI elements remain within the visible area of the headset's screen.

Keywords: Augmented reality, Human-computer interaction, User interface application, Warehouse.