

# Surrogate Shopping System : Experience of Semi-onsite Shopping under the Dual-task Situation

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**Abstract**— We propose a “surrogate shopping system” allowing users to shop in stores while performing tasks at home. A mobile robot with a robotic arm and camera enables users to view both home and store environments via a head-mounted display, performing household and shopping tasks simultaneously. We compared two interaction methods: a master-slave arm manipulation and a laser pointer-based item selection. The study showed a preference for the pointing method due to its usability in a dual-task situation, though the master-slave method allowed for more detailed shopping.

## I. INTRODUCTION

Shopping can be a hassle when busy with work or childcare. Online shopping often lacks the detailed information available in physical stores. We propose a “surrogate shopping” system, enabling real-time physical store shopping without interrupting current tasks.

This system requires users to control two bodies: their natural body at home and a robotic surrogate in the store. Existing robotic shopping systems do not support simultaneous local task performance [1], and human augmentation robots are typically wearable or fixed [2]. Balancing task convenience and user satisfaction is crucial, as immersive remote shopping may interfere with local tasks.

We present a surrogate shopping system prototype for semi-onsite shopping, describe its technical configuration, and report user study results.

## II. SYSTEM REQUIREMENTS

To achieve a semi-onsite shopping experience, two conditions are necessary: 1) a surrogate robotic body that can move and pick up items remotely, and 2) the ability to control and monitor it while working locally. Our previous study developed systems for controlling a robotic arm remotely while presenting images of both environments to the user simultaneously [3]. We also developed a camera system that moves with the user’s upper body movements [4], integrated into a mobile cart to meet both requirements.

We analyzed the trade-off between immersion in the surrogate body and dual-task efficiency by testing two merchandise-grabbing methods. The “pointing mode” uses a laser pointer to specify items, which the robot arm retrieves automatically [5]. “manipulation mode” involves a master-slave control method, mimicking the user’s arm movements [6].

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## A. System Description

Fig. 1 shows the system configuration. The mobile cart, 70 cm high and 40 cm wide, includes a camera module that synchronizes with upper body movements [4] and a Mycobot robotic arm. The cart moves horizontally at 90 cm/s and turns at 30 deg/s. Users control the surrogate body via HTC VIVE controllers. In manipulation mode, the controller synchronizes with the robot hand, while in pointing mode, users point at products with a laser pointer, and the robot retrieves them via voice commands like “Take it.”

The 45 kg robot system includes a cooling fan, developer display, and a variable power supply (24 volts, 2.5 amps). User actions are communicated through ROS, with commands sent via Unity, operating over WiFi with a 30 ms delay.

## III. USER STUDY

### A. Procedure

The developed prototype was tested by five users, evaluating the satisfaction of the shopping experience in two operating modes through task completion time and subjective evaluation. Users performed the main task of shopping remotely while engaging in a quick reaction game locally. For the main task, users retrieved three pre-specified items and moved to the goal, with task time recorded. Items were randomly chosen, and their locations were provided in advance to ensure equal distance for all users. For the subtask, users pressed a button to keep a flame animation lit when it began to shrink.

Five subjects (aged  $27.4 \pm 5.6$ , healthy adults in their 20s-30s) participated, performing the experiment under four conditions: two operation methods (pointing mode and manipulation mode) and two shopping conditions (main task only and dual-task). After the dual-task condition, participants completed a questionnaire using a seven-point Likert scale on subtask workability (Q1: well performance, Q2: easy to notice, Q3: continuous attention) and shopping performance (Q4: satisfaction, Q5: less interruption, Q6: presence in the store, Q7: initiative in shopping).

### B. Result and discussion

Fig. 2 shows the average required time for the main task. Due to the small sample size, statistical analysis is reserved for future work. However, most subjects shopped more efficiently in pointing mode than in manipulation mode

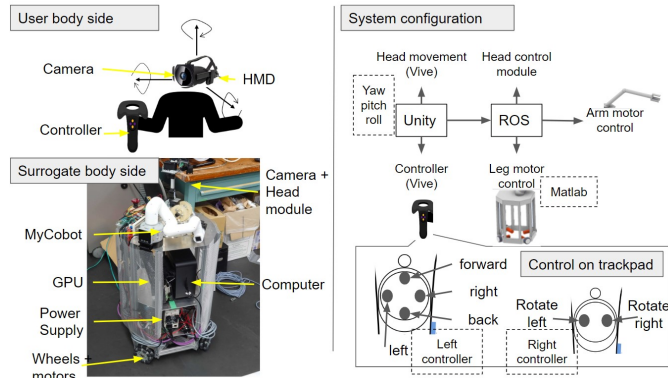


Fig. 1. Hardware and system configuration. Head module with camera, robot arm and mobile cart are controlled by HTC VIVE.

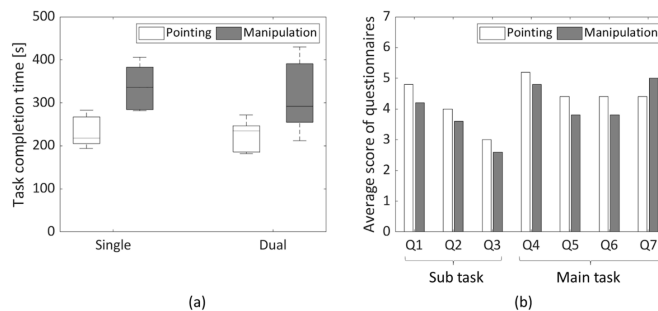


Fig. 2. Results of the user study. (a) Task completion time of the main task, (b) Scores of questionnaire in 7 (strongly yes) to 1 (strongly no).

during dual-task conditions. In both modes, subjects resumed shopping with minimal influence from subtasks.

Questionnaire results indicated that respondents in pointing mode had more time for subtasks (Q1-3), while those in manipulation mode felt more in control of the shopping (Q7). Interviews revealed that the manipulation mode was more challenging due to difficulty in grasping depth, making the pointing mode less stressful and generally preferred (Q4).

#### IV. CONCLUSION

We proposed a new style of shopping with a surrogate shopping system and developed a prototype for semi-site shopping while performing another task. A user study demonstrated that shopping could be done while dual-tasking using two operation methods. Future work will investigate hybrid operations, such as switching from pointing mode to manipulation mode mid-shopping for detailed product inspection. Additionally, the effects of immersion and convenience on the shopping experience will be explored to enhance satisfaction.

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