Intelligent Shop Window

Producing Dynamic Situated Augmented Reality using a Large See-through Screen

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Abstract— **The purpose of shop windows is to attract people's attention and increase the consumers' desire to buy the merchandise. This paper proposes an "intelligent shop window" that can display merchandise information and advertisements on a large see-through display overlaid on real items or people in the shop. The system decides the target item to be advertised based on the position of the customers/shop clerks and the color of the clothes that a clerk is wearing. Then, it displays the information about the item on a window-like see-through screen through which passers-by can see the information overlaid on the situation inside the shop. As compared to the mannequins in a shop window, our system can present information dynamically. Therefore, it is expected to attract greater interest from passers-by and increase the number of customers visiting the shop.**

Keywords - augmented reality; shop window, overlaid display, Kinect sensor.

I. INTRODUCTION

Pedestrians on a street look at the shop windows of the small shops and department stores. Shop windows attract people's attention and have the effect of increasing the consumers' desire to buy. Through the shop window, people would like to see whether the shop sells items matched with their preference, and who the customers are (age, status, sense of fashion). Then, if the shop looks good, they step into the shop. Therefore, the information inside the shop is very important for the customers to decide whether they go into the shop or not.

By virtue of the development of larger displays, production technologies, and human sensing technologies, many studies on interactive displays have been conducted. These display systems can recognize the environment of public places and change the displayed information accordingly in real time. For example, such systems were used in exhibitions at museums [1][2]. Other systems can project information onto the facade of buildings [3][4].

When designing information display systems for shop window interfaces, the essential roles of a shop window should be considered. Doorn et al. [5] suggested that the shop window has three roles as a marketing tool.

1. It expresses the style of the shop;
2. It creates the appropriate atmosphere and attracts people;
3. It informs people about the available products and their function.

The objective of many of the previous systems was to attract pedestrians and allow them to interact with the system. The Dynamically Transparent Windows system [6] utilizes foil that becomes transparent when energized. By making a specific small area transparent according to the movement of the pedestrians, the system changes the displayed products and areas in the shop that are visible to the pedestrians. With the goal of providing an ambient response to the users' input, in the Persuasive Interactive Mannequin system [7], mannequins displayed in the shop window gaze at the customer looking into the window. Moreover, Müller et al. [8] reported that the users' degree of interest differed according to the method of giving feedback via an interactive display that can interact with passers-by in public places.

However, many previous systems were more interested in recognizing the presence and motions of passers-by, but not in recognizing the situation inside the shop. Our study, on the other hand, focuses more on the environment inside the shop because the information inside the shop is useful for the users to decide whether to step in the shop or not. Thus, our "intelligent shop window" attracts the attention of passers-by by changing the display information according to the environment inside the shop. The passers-by are able to observe the situation inside the shop through the window. In addition, they can see overlaid information related to the people and items inside the shop. When no people are close to the window, the shop window displays promotion materials that represent the style of the merchandise inside the shop. The system can also show the details of the items when people are close to the window.

The rest of this paper is organized as follows: Section 2 describes in detail our proposed system. Section 3 describes the implementation of the system. Following this, Section 4 presents an example of application. And finally, Section 5 summarizes this paper and mentions future work.

II. PROPOSED SYSTEM

We propose a display system that resembles a conventional large shop window adjacent to the sidewalk through which users can see enhanced information about inside a clothes shop. Basing its decision on the clothes that the customers and shop clerks are wearing and their position in the shop, the system selects an item that is popular or recommended and overlays the advertisement information

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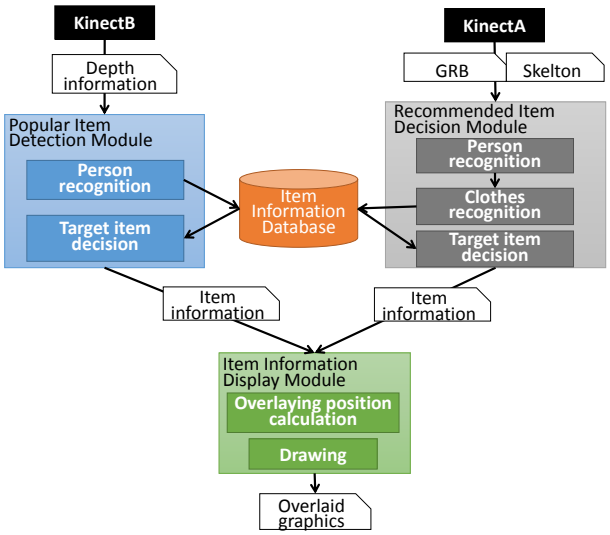

Figure 1. System architecture

related to the item on the shop window. The advantage of this system is that the advertisement information is automatically generated by recognizing the shop clerks, and it is not needed to be manually changed/registered every day. Moreover, this system enables the passers-by to observe that many customers are gathered around a popular item and see the information about it, which is overlaid on the window. They can also see recommended items by looking at information overlaid near a shop clerk who is wearing the item. This function allows the passers-by to get better idea about inside the shop as well as the information about popular items.

Our proposed system consists of a popular item detection module, recommended item decision module, item information database, and item information display module. The system architecture is shown in Figure 1. A detailed explanation of each module is presented below.

A. *Popular Item Detection Module*

We define a "popular item" as an item around which many people gather or which they stop to pick up and examine. In order to detect a popular item according to this definition, the people and the item close to which people are standing must be recognized. It is also necessary to determine whether a person is only passing by or examining the item. If the person is examining the item, the system retrieves the item data by searching the product database and sends the information to the display module. However, when many people are present in the shop, the information overlaid on all the customers can be a source of irritation. In such a situation, our system identifies crowded locations based on the recognition of the position and movement of people and prioritizes the most crowded location when displaying the overlaid information. For people recognition, depth information sensed by a Kinect sensor is used.

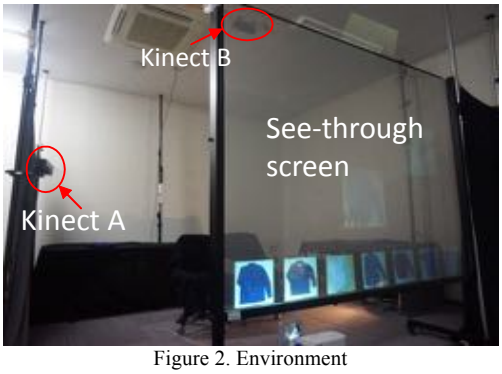

Figure 2. Environment

B. *Recommended Item Decision Module*

As an advertisement of the shop, the system displays the information about special items that characterize the sense of fashion of the shop. For this purpose, our shop window system recognizes special items that shop clerks are wearing (we assume that the shop clerks wear the special items as advertisement), and displays the information about the special item when a clerk passes near the shop window. The item information is displayed according to the position and movement of the shop clerk. To achieve this, the module recognizes a person inside the shop passing by the window and recognizes the item that he/she is wearing using RGB color information and a simple pattern matching technique. Then, using these data as keys, the module searches the item information database, and sends the results to the information display module. Note that this function enhances the information inside the shop, and make the special items attract the attention from the passers-by.

C. *Item Information Database*

This database is used for detecting popular items and recommended items. For both these purposes, the item name and its RGB image must be registered. In addition, for detecting popular items, the layout of the shop, that is, the display location of each item, is required. The system measures the depth image around the locations where the popular items are displayed in order to recognize a crowd. For detecting recommended items, the RGB values are required so that the clothes that the shop clerks are wearing can be recognized.

D. *Item Information Display Module*

When the target items have been determined using the popular item detection module and the recommended item decision module, and information about the items has been obtained from the database, the item information is sent to the item information display module, which displays the information on the window.

The information should be appropriately overlaid so that the advantage of window interfaces that passers-by can see inside the shop is not impaired. The system satisfies this requirement using the following two methods.

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Figure 3. Depth image for the person recognition

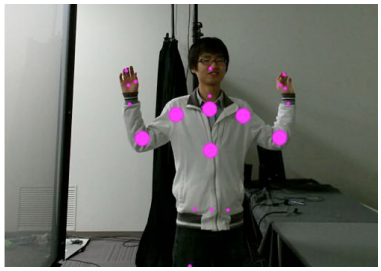

Figure 4. Positions of six joints for Clothes Recognition

- It determines the overlaid display by considering the number and position of target items;
- It prioritizes the items around which many people gather and those which a shop clerk is wearing.

III. IMPLEMENTATION

A. Environment and Equipment

We described the implementation of the proposed system in the previous section. The environment and the equipment are shown in Figure 2. We set up a 4 m × 4.25 m area as a shop. In this area, a 100-inch see-through screen (2.0 m × 1.5 m) was located on one side of the area as a shop window. Since real glass is not suitable for projection purposes, we used a see-through screen glued onto a large thick acrylic board. For person and clothes recognition, we used a Kinect for Windows v2 open Beta (hereinafter, referred to as the Kinect sensor) and a Kinect SDK 2.0. For person recognition, we set up a Kinect sensor on the ceiling (2.9 m in height) and obtained the depth image as viewed from the top (Kinect B in Figure 2). For clothes recognition, a second Kinect sensor (Kinect A) was set behind the screen.

B. Person Recognition

In order to implement the popular item detection module, the people gathered around an item must be recognized. We used a Kinect sensor attached to the ceiling to obtain the depth image as viewed from the top. The depth image resolution is 512 × 424 pixels, and the pixel data are processed by OpenCV library. Figure 3 shows an example of the depth image. There is a person at the center of the picture. We can recognize him/her with the depth information. For detecting crowded locations, a sensing area is predefined for each item, and the system monitors the depth data in this area. Before the system is initiated, that is, when no person is present in the area, the depth image of each sensing area is measured in order to calibrate the sensor. When the system has been initiated, if a certain amount of change from the initial depth information is detected, we count a sequence of the pixels, the depth data of which changed from the original values. If the number of pixels in a given sequence is larger than a threshold, the system recognizes that a person has entered the area. If the number of pixels is smaller than the threshold, the result is discarded as noise. It sometimes occurs that a person only passes by the item and stays inside the area for a very short time. In this case, the number of frames during which the person stays inside the area is counted. If the number of frames is larger than a threshold, i.e., the person stays inside the area longer than the threshold, the system recognizes that this person is examining the item.

When the variation in the depth data is sufficiently large, the system assumes that many people are remaining in the area and the item is popular. As the popular items should be prioritized over other items in the overlaid display, in addition to the position of the target item, the system measures the size of the area where the depth image variation is large and sends the information to the item information display module.

C. Clothes Recognition

In the recommended item decision module, a function for recognizing the clothes that a shop clerk walking near the shop window is wearing is required. In the current implementation, we used RGB color data sampled from several points on the clothes and applied them in a simple pattern matching technique.

First, using the Kinect SDK, the system obtains the skeleton (position) and RGB color information for 25 joints. As shown in Figure 4, we used RGB information for six joints: SpineMid, ShoulderLeft, ElbowLeft, ShoulderRight, ElbowRight，and SpineShoulder. The sensing area of the Kinect sensor is restricted such that persons outside the shop window are not recognized as being inside the shop. When a person is detected and tracked, the RGB values of the six joints are measured. Then, using a Sum of Squared Difference (SSD) method, these values are compared with the RGB value for each item in the database. If the SSD value is smaller than a threshold for more than two data points among the six, the system determines that the input data match the candidate item. Then, to obtain the position of the person who is wearing the recognized clothes, the position of the SpineMid joint is obtained, and its distance from the Kinect sensor is calculated based on the position data. Finally, the information about the item and the distance between the Kinect sensor and the clerk are sent to the item information display module.

D. Overlaid Display

In the item information display module, the results of the person and clothes recognition are processed, and the item information is then displayed. To avoid obstructing the view

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Figure 5. A person examining an item

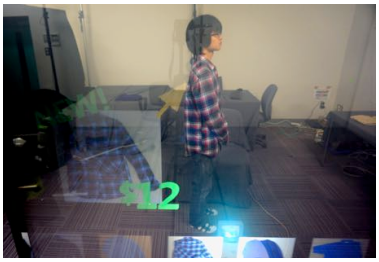

Figure 6. A shop clerk wearing a recommended

of the passers-by into the shop, only three items, which were selected as the advertisement targets in the previous 30 sec, are displayed.

For displaying the item information that is sent from the popular item detection module, the information is overlaid on the real target item in the shop. Thus, the display position is determined based on the position of the item. For displaying information about the recommended items, the information must be overlaid such that the passers-by can easily identify who is wearing the recommended item. We use the position of the clerk wearing the clothes for determining the display position.

IV. EXAMPLE

This section shows how the implemented mockup system works using a simple example. Figures 5 and 6 show snapshots of our intelligent shop window. There are five items in the shop. At the bottom of the window, the graphics of all items are displayed repeatedly.

Figure 5 shows that the system detects a person who is examining an item, and overlays the advertisement about the item. In this example, the graphics of a shirt and an advertisement phrase "ON SALE" are overlaid close to the person.

Figure 6 shows an example of a recommendation. The system recognizes a shop clerk and his clothes, and then, it displays the advertisement of the item by overlaying it on the clerk. In this example, a yellow arrow is drawn to clearly identify the person wearing the recommended clothes.

V. CONCLUSION AND FUTURE WORK

In this paper, an intelligent shop window that can display information and advertisements of items sold in the shop was proposed. The system decides the target item to be advertised based on the position of customers/clerks and the color of the clothes that the clerk is wearing. Then, the system displays the information about the item on a window-like see-through screen through which people passing by the window can see the information overlaid on the situation inside the shop. Since this system can produce a more dynamic display than mannequins in a shop window, it is expected to attract more interest from the passers-by and increase the number of customers visiting the shop.

In future work, the capability of the system to distinguish between shop clerks and customers should be improved since, in the current implementation, the system cannot achieve this. This capability is important, since in the popular item detection module, only customers should be counted as members of a crowd, and in the recommended item decision module, only a clerk should be tracked. In addition, the clothes recognition function does not allow the current system to recognize clothes with a complex design, since we applied a simple pattern matching method that uses RGB values. To improve the clothes recognition function, it is necessary to employ more sophisticated computer vision technologies. Finally, our ultimate goal is to use this system as a real shop window and test whether the system can attract more passer-by attention.

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