IJACT 21-6-13

# A Study on the Automated Payment System for Artificial Intelligence-Based Product Recognition in the Age of Contactless Services

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## *Abstract*

*Contactless service is rapidly emerging as a new growth strategy due to consumers who are reluctant to the face-to-face situation in the global pandemic of coronavirus disease 2019 (COVID-19), and various technologies are being developed to support the fast-growing contactless service market. In particular, the restaurant industry is one of the most desperate industrial fields requiring technologies for contactless service, and the representative technical case should be a kiosk, which has the advantage of reducing labor costs for the restaurant owners and provides psychological relaxation and satisfaction to the customer.*

*In this paper, we propose a solution to the restaurant's store operation through the unmanned kiosk using a state-of-the-art artificial intelligence (AI) technology of image recognition. Especially, for the products that do not have barcodes in bakeries, fresh foods (fruits, vegetables, etc.), and autonomous restaurants on highways, which cause increased labor costs and many hassles, our proposed system should be very useful. The proposed system recognizes products without barcodes on the ground of image-based AI algorithm technology and makes automatic payments. To test the proposed system feasibility, we established an AI vision system using a commercial camera and conducted an image recognition test by training object detection AI models using donut images. The proposed system has a self-learning system with mismatched information in operation. The self-learning AI technology allows us to upgrade the recognition performance continuously.*

*We proposed a fully automated payment system with AI vision technology and showed system feasibility by the performance test. The system realizes contactless service for self-checkout in the restaurant business area and improves the cost-saving in managing human resources.*

*Keywords: Contactless Service, Artificial Intelligence, Kiosk, Self-Checkout, Image recognition*

## 1. INTRODUCTION

Contactless services such as online shopping, teleworking, online classes, telemedicine, and unmanned convenience stores, which have become rapidly daily life due to the recent outbreak of COVID-19 [1]. The increasing number of contactless people seeking non-face-to-face consumption activities that minimize contact

with people is raising interest in unmanned kiosk systems that can order and calculate non-face-to-face methods. Among the various business areas that attempt to unmanned, the service industry is the fastest-running field for unmanned technology. With consumers already feeling the convenience of unmanned payments, the contactless trend is expected to keep growing as time goes by due to non-facing services and digital technology innovation. Besides, employers, whose labor costs have increased due to the surge in the minimum wage, are reducing overall working hours by reducing employment or reducing operating hours in relatively small customer hours. For example, because barcodes cannot be attached in the baking industry, employees manually tag products out of dozens of categories by looking at the appearance of the product, causing inconvenience due to latency. To address these problems, we proposed an AI-based item recognition automation payment system.

## 2. RELATED RESEARCH

### 2.1  Contactless service

  Recently, consumer culture has been valued by getting what it wants without contacting others, which is reflected in services. Consequently, service providers are introducing contactless services that are non-face-to-face to deliver services that meet consumer needs [2]. Innovation in digital technology has enabled the restaurant industry to receive the necessary services even if the service providers and the service receivers do not meet in person [3]. Also, consumer attitudes are rapidly spreading information and spreading contactless consumer culture due to the growth of single-person households that value sharing and experience, actively utilize Internet-related devices and services, and the influence of millennials [4]. ICT development through technology innovation leads to self-service technology that provides customized services to customers' tastes, needs, and lifestyles [5].

   In Korea, "Untact" is a compound word that combines the word "un" with the word "contact" and can be defined as providing non-face-to-face information or trading goods [6]. Many businesses have introduced unmanned order payment systems, kiosks and self-service counters to provide Untact services or self-service technologies, and these services are now actively supported in offline stores in Korea [7].

### 2.2  Kiosk

   Kiosk, which allows customers to place orders without facing employees, is a growing technology-based self-service and an unmanned payment system that allows customers to search for menus and even order and pay for themselves. Kiosk provides a touchscreen, unattended guidance system that allows customers to order and pay directly, replacing the previously used orders and payments [8]. The introduction of unmanned payment devices in the service sector increases due to the surge in the minimum wage. Kiosk replaces the work performed by the workforce and reduces the minimum number of employees required for business [9]. The kiosk market is growing, and the latest technology grafts are used in more diverse fields and have the potential for much growth.

### 2.3  Self-learning object detection

   Object detection is a technology including computer vision and image processing that detect target objects in images or videos and indicate the region of the target object. The target object contains certain classes such as cars, animals, or humans. Object detection has applied various areas of computer vision, including self-driving and intelligent surveillance [10].

   Self-learning is the ability to recognize and learn patterns automatically from data. The learned or trained AI models become more intelligent by improving themselves [11].

## 3. PROPOSAL OF AI-BASED SELF-CHECKOUT SYSTEM

A novel self-checkout method is needed for the items without barcodes to realize a fully automated self-service checkout system in restaurants and food stores. Figure 1 shows the comparison service flow between conventional and proposed self-checkout systems. As shown in Figure 1a, the items with barcodes can be processed by matching product and price information using a barcode scanner in the conventional payment system. However, the items without barcodes have to be processed manually by staff or operators. In our proposed system, the items without barcodes can also be processed automatically using an AI vision scanner. Because the AI vision scanner recognizes item's images and automatically matches the payment information, any manual input process is not needed by staff, even for the items without barcodes.
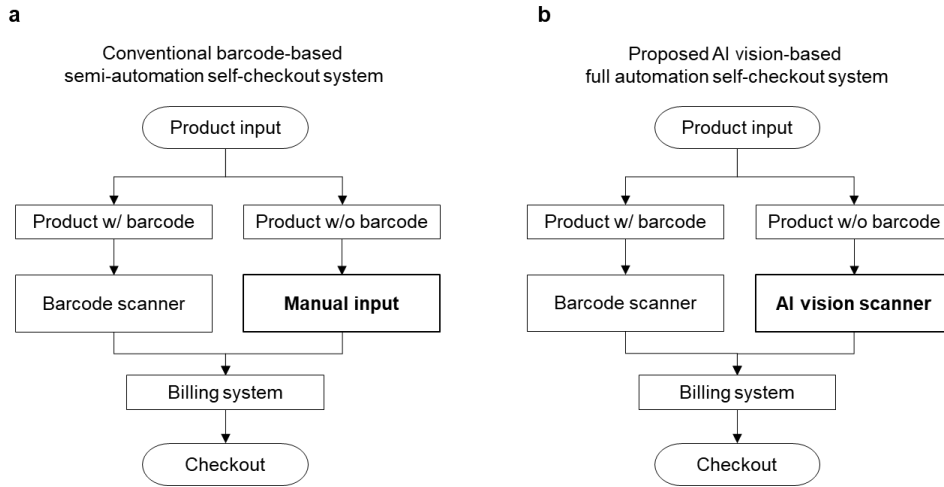


**Figure 1. Service flow of conventional and proposed checkout system. a semi-automated service flow in a conventional barcode-based self-checkout system. b full automated service flow in the proposed AI-based self-checkout system**

Figure 2 shows the processing flow in the proposed AI vision scanner. The AI vision scanner consists of a camera module and light source for image acquisition of items without barcodes. The process of AI-based image analysis poses AI-based product detection and classification to match the payment information. The acquired image is input to AI models for detecting and classifying the items listed in the billing system. The payment information is automatedly calculated with matching to the price information of each item in billing system. The billing process is completed by matching all items detected by the AI vision scanner with the payment information.
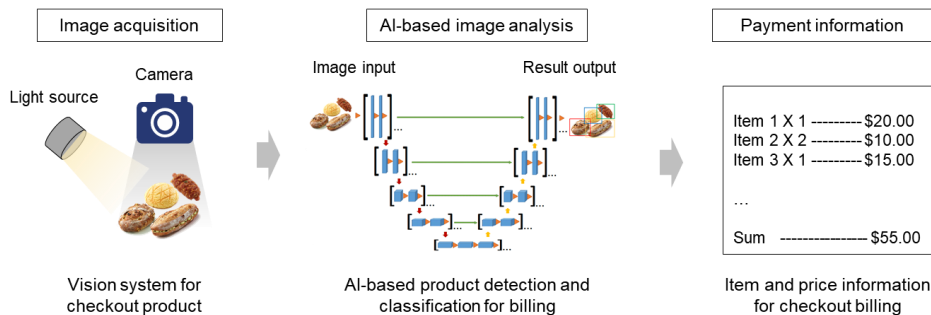


**Figure 2. Processing flow in the proposed AI vision scanner.**

Figure 3 shows the whole service flow in the proposal system. Due to the feature of the AI system, it is necessary to separate processes into whether artificial intelligence learns or normally operate.

In the normal operation mode, the AI vision scanner performs image acquisition. After pre-processing the acquired image for normalization, the integrated AI algorithm performs object detection and classification in the image. The detected objects match the stored items and prices. When all matched items are correct, the user can proceed billing system. However, if the items and prices are mismatched, the user can edit the information manually.

The training dataset is prepared in learning mode by labeling the input images that include the mismatched information in normal operation mode. An upgraded AI model is created by retraining the current AI model using the newly labeled image dataset. When the retrained AI model is confirmed to have a better performance at the validation process, the retrained AI model switches to the current AI model, making the AI vision scanner upgrade.
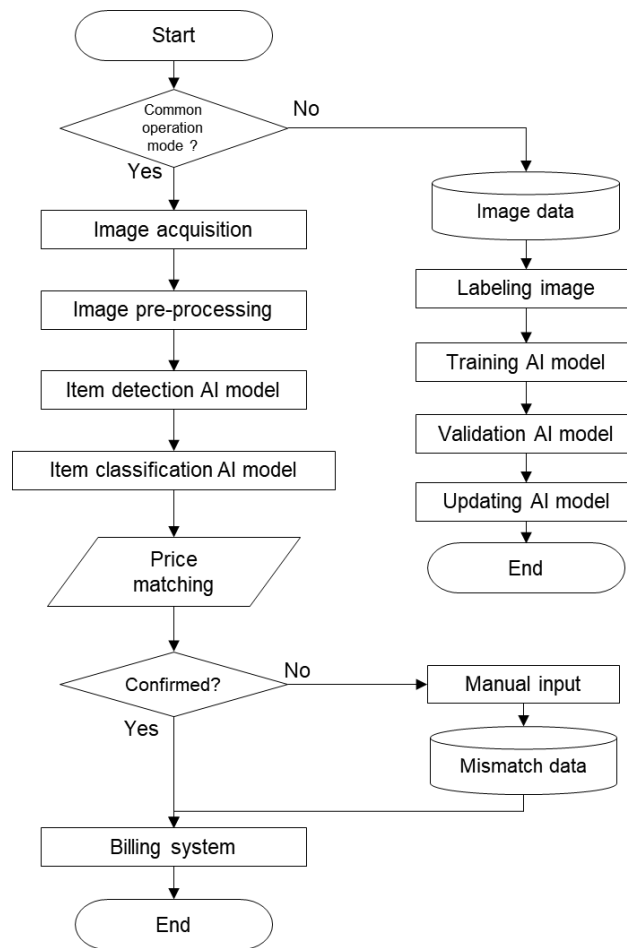


**Figure 3. Flowchart of the proposed AI vision-based self-checkout system**

## 4. DEVELOPMENT OF AI-BASED SELF-CHECKOUT SYSTEM

The proposed system consists of three hardware components: camera module, AI server module, and self-checkout kiosk module. Figure 4 shows the system and service schematic diagram of the proposed system. We inserted target items in the camera module to prepare a dataset for training the AI model to recognize items without barcodes. The objects in acquired images are labeled with bounding boxes matching the classes with

the item's codes and prices. The labeled image dataset is transmitted to the AI server module and applied to train an AI model with classification classes matching the input items. The trained AI model is deployed and provides inferencing results to the self-checkout kiosk system with bounding boxes and item codes on the input image from the image of the customer's shopping items. When the mismatch between the detected object and preset item is observed, the user inputs the mismatch information to the AI server through the user interface of the self-checkout kiosk.
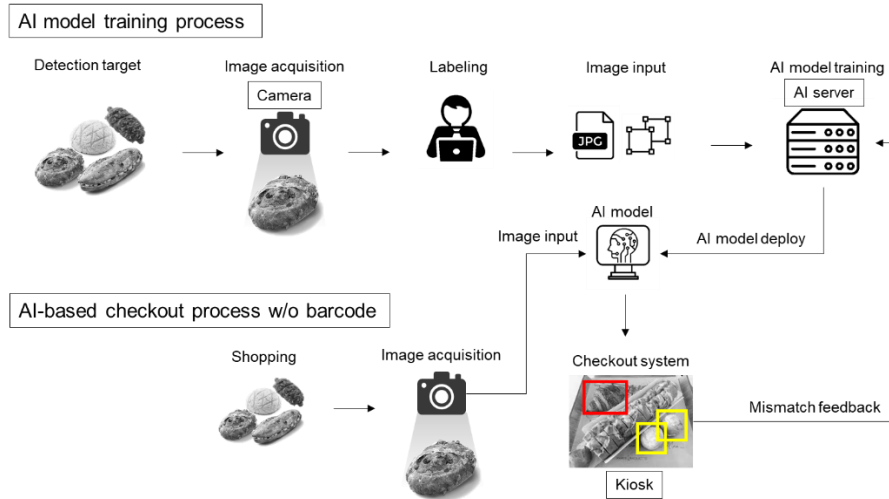


**Figure 4. System and service schematic diagram of the proposed system**

The proposed system was developed in a Visual Studio environment using C#. Moreover, the AI model was developed using Python and Keras framework. Figure 5 shows the developed visualization result of object detections from the trained AI model in the input image that contains different donuts.
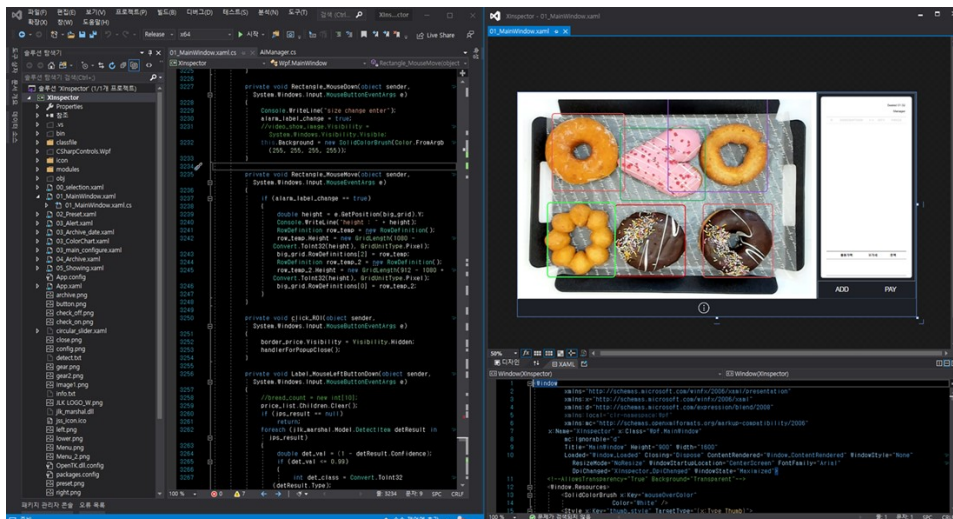


**Figure 5. Visualization result of object detections from the trained AI model**

## 5. CONCLUSION

We proposed a fully automated payment system with a state-of-the-art AI vision technology and showed system feasibility by the performance test.  As the number of consumers who want non-facing increases due to the global pandemic of COVID-19, the use of unmanned checkout counters increases. However, most of the conventional self-checkout systems rely on barcodes, QR codes, or RFID on the product items to match the price information. Therefore, the proposed AI-based self-checkout kiosk system is a practical solution to address the difficulty in recognizing items without barcodes, QR codes, or RFID.

The proposed system can be applied to fresh food stores, bakeries, and self-restaurants on highways, which cause increased labor costs and many hassles. We established an AI vision system using a commercial camera and verified the usefulness of the proposed system by validating object detection AI models using donut images. The proposed system has a self-learning system with mismatched information in operation mode, and it allows us to upgrade the recognition performance continuously.

With the help of this kind of innovative digital payment system in the required areas, the user payment patterns can make the advantage for identifying the needs of returning customers based on frequently used time slots, preference menus, and payment amount. It can also develop new menus and recommend menus through customized information analysis for customers, increase customer convenience, improve efficiency, and increase sales.

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