A New Tool for Personalized Advertising in Shopping Malls: A Smart Billboard System

AbstractAlong with the differences in customer preferences, a strong competition has emerged among the companies. Marketing managers have begun to design their marketing plans according to the target markets' needs and expectations. At this point, value-oriented marketing activities have become even more important. Personalized marketing is one of the most effective way of creating value to consumers. It is one of the best ways to establish relationships with target markets. Personalized marketing aims at delivering individualized messages to customers. By this means, personalized marketing activities attract more consumer attention relatively. It is a fact that it can also have positive impacts on the sales of the business. In this paper, a conceptual framework on personalized advertising is proposed. In this context, a hypothetical smart billboard system is designed at a shopping mall's entrance. The camera mounted system affirms the car license plates via image processing methods. A database is associating the detected license plates with the customers. When any match is found, the screen shows relevant advertisement to the customer. The study's major contribution is to propose a smart billboard system for shopping malls that presents personalized advertisements to customers based on their previous shopping experiences.

Keywordsimage processing, license plate recognition,personalized advertisements,Personalized marketing,smart billboards.

Comment [RS1]: Should be clear according to Method (segmentation/classification/Clusering/ or the other) and Algorithm used

1. Introduction

Along with the diversity in consumer preferences, fierce competition has arisen among the businesses. Decision-makers in the businesses have begun to revise their marketing strategies according to the wants and the needs of the target markets. To be successful, especially value-focused marketing strategies have gained importance.

Personalized marketing is one of the best ways of creating value for consumers. Basically, it is an efficient way of building one-to-one relationships with the target markets. Personalized marketing efforts aim to present individualized offerings to consumers. Therefore, this new strategy is started to attract the attention of businesses in recent years. By utilizing personalized marketing, it can be easy to satisfy the unique needs of the consumers more accurately.

As in the marketing mix elements such as product, price, and place also in the promotional activities of the businesses, personalization is started to be a new marketing responsibility for the businesses [22]. Personalized advertisements have many advantages both for businesses and consumers. First, it will be easier to bring together the businesses and the right customers. Thereby, the right advertisements will be shown to the right

consumers. Thus, the effectiveness of the advertisements can increase. Besides, personalized advertisements help businesses to reduce their advertising costs. Furthermore, consumers can find information about the products and services that can satisfy their needs. Matching the advertisements with the correct consumers can remove the disturbing effects of them. The results of the studies show that consumers were found to be satisfied with personalized advertisements [12].

Billboards are quite important tools in outdoor advertising. Taylor et. al. [3] stated that "name identification, location of the billboard, readability, clarity of the message, use as a tool of integrated marketing communications (IMC), powerful visuals, clever creative, and information provision" are among the elements of successful billboard advertising. There are many advantages of using billboards in terms of businesses. Advertisements can be seen by many people at any time of the day. They are visually striking, relatively easy to create brand awareness compared to other media tools and can be preferred due to low production cost. The main disadvantages of billboard advertisements include the word limit, limited advertising time and perceiving the advertisements unconsciously [3, 15]. As a result, billboard ads are found to be more effective than other media tools in some ways such as reaching new customers, sending messages at low cost to the target market and thereby increasing the sales of the business [3].

Over the years, there have been many changes in the promotion activities of the businesses. However, the importance of billboards has not changed in time. Along with the technological developments, in the following periods, the efficiency of billboards has been increased more. Today, evolving technology allows people to interact directly with the billboards. Interactive Wireless Electronic Billboards are developed based on technology and these billboards make advertisements more noticeable by consumers [10].

In this paper, a conceptual framework that enables the personalization of advertisements is proposed. To do that, a hypothetical smart billboard system is set up at the entrance of a shopping mall. The camera mounted system recognizes the license plates of the cars via image processing techniques. The detected license plates with the customers are associated with a database. Once any match is found, related advertisements are shown to the customer on the screen. The major contribution of the study is proposing a smart billboard system that presents personal advertisements to customers according to their previous shopping experiences. The system recognizes the customers from their car's license plates. In this respect, the system can be regarded as novel among the other smart advertisement systems, which are typically based on the identification of personal profiles such as gender, age interval and physical appearance. The other advantage of the system is the simplicity and low-cost design. The system can operate with a mid-price camera to capture the image features, perform the image processing operations and database query retrieval with open-source software platforms easily, and use a simple LCD to show the advertisements.

The rest of the paper is organized as follows:

Section 2 focuses on the related works about the interactive billboard systems as well as the corresponding methods used. In Section 3, a survey that is conducted to determine the consumer needs, and its results are exhibited. Section 4 presents the proposed conceptual framework based on license plate recognition. Section 5 demonstrates the results of the study and its implications. Finally, the conclusions and recommendations are provided in Section 6.

2. Related Works

Along with the expansion of personalized advertisements, there have been various attempts to develop smart advertisement billboards. There are wide advertising opportunities at shopping centers, roadsides, overpasses, and parking lots. In shopping centers, kiosks or ad panels are widely used as marketing tools [8]. On the other hand, roadside, overpass, and parking garage advertisements are strategically located in heavily trafficked vicinities [6,9]. Some examples of those advertisements are illustrated in Figure 1. Although this type of advertising is attractive and effective, a vast amount of them lacks personalized messages.

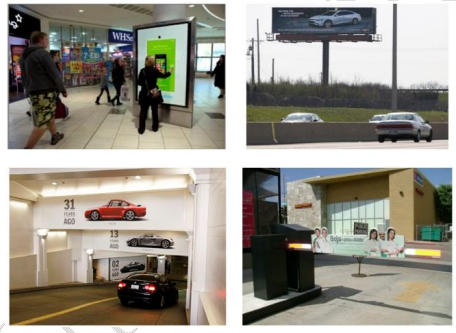

Fig. 1. Examples of various types of advertisements [6,8,9]

With the rapid development of the public transportation system, vehicle identification systems have become more and more popular in outdoor advertising. However, there are only a few examples focused on personalized advertisement systems that target cars and their individual motorists. According to an article published in McClatchy, it is stated that "smart digital billboards will detect the make, model and year of oncoming vehicles and project ads tailored to the motorist." [23]. An example of targeted highway ad, conducted by a technology company (Synaps Labs), is encountered in Moscow. A roadside billboard captures images of cars via high-speed cameras. Then, a machine-learning algorithm recognizes the make and model of the cars. Afterward, as the car passes, a bidding system selects the appropriate ad to be shown on the billboard [20]. In a different study conducted in Japan, a smart billboard system aims to identify the make and the model of vehicles and displays a targeted advertisement. It is also stated that pilot tests are quite promising, which yield %94 accuracy [15]. Two new projects are initiated in the UK and Japan that provide real-time car recognition. The digital billboards at the exit of a traffic circle near a shopping center identify individual car types from their license plates and present advertisements to drivers or passengers [1]. In a different project named "DeepAd", it is planned to detect and identify cars by an innovative digital billboard system. The project employs recognition, identification, and control through machine learning and deep learning to turn big data into smart data. The preliminary tests showed that 94% accuracy was provided to detect and identify the cars [7]. A giant digital billboard in London's Piccadilly Circus is initiated to track cars to target ads. The cameras behind the screen track the make, model, and color of passing cars to deliver targeted advertisements. It is also possible to show specific ads when a cer-

Comment [RS2]: typo

tain model of car passes the screen [16].

Vehicle identification can be performed in various ways such as vehicle model/manufacturer recognition and traffic management. Except for those, all vehicles must have a license number, which can be used as a unique identifier. Automated License Plate Recognition (LPR) is a 3-stage process, used in digital image processing. These stages are (i) license plate detection, (ii) character segmentation and (iii) optical character recognition (OCR) [4]. License plate detection aims to localize the license plate within the input image. On the other hand, character segmentation partitions each character in the license plate. In the OCR stage, the recognition of segmented characters is performed by using various pattern analysis techniques. Most of the efforts seen in the literature are based on binary / gray-level image processing algorithms, image classifiers, or pattern matching techniques. In a study, real-time automatic license plate recognition is performed for CCTV forensic applications. In the pre-processing step, background learning, median filtering, and morphological operations are employed. The localization step is performed through a histogram of oriented gradients feature extraction method and nearest mean classifier. In tracking an approach based on Lucas Kanade's algorithm is utilized. Finally, the recognition step is carried out by employing nearest neighbor classifier learning and character segmentation using MBR on binary maps [18]. In a more recent study, vehicle license plate recognition is performed by a method based on character-specific extremal regions and an offline trained pattern classifier of hybrid discriminative restricted Boltzmann machines [2]. Further, an Automatic Plate Number Recognizer (APNR) based on neural networks and genetic algorithms is proposed. A genetic algorithm is used to estimate the optimal number of hidden neurons, momentum rate, and learning rate. APNR is composed of several image processing functions such as grayscale conversion, top-hat transformation, binary morphological operations, thresholding, binary image projection, and segmentation [11]. In a different study, multiwavelet transformation is employed to detect license plates. The paper focuses on the localization phase of automatic number plate recognition by proposing a new concept called "multiwavelet". The study also resolves tilted number plates by performing a skew correction algorithm [13]. A novel cascaded approach is proposed to recognize license plates. The method includes a set of operations such as plate localization based on a series of classifiers, character segmentation, and character recognition. State identification and confidence assignment steps are also employed in the proposed framework [21]. In a different license number plate recognition system, entropy-based features selection approach with a support vector machine (SVM) is presented. The proposed architecture is composed of several steps such as the selection of color space channel, binary segmentation of selected channel, the fusion of Histogram of oriented gradients (HoG), and geometric features and classification using SVM [14]. A Deep Convolutional Neural Network (DCNN) for license plate recognition is proposed in a different study. The proposed system consists of a combination of layers for checking the exis-

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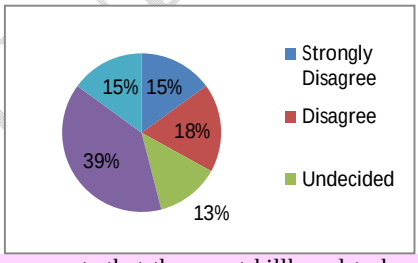
tence of a license plate and for recognizing digits and characters [5]. In a more recent study, an effective license plate detection system is presented. To do that many AdaBoost cascades with three levels pre-processing local binary pattern classifiers (3L-LBPs) are employed. The proposed approach resolves many difficult cases such as dusk, dirt, low/high contrast, fog, and distortion [17]. In our proposed method, as a first step, we employ a license plate detection technique based on a sequence of image processing operations such as analysis of vertical and horizontal edges, probable plate determination, and connected component analysis. In the license recognition phase, segmentation of the digits and letters using image morphology is employed first. Then, a correlation-based image matching approach is performed. The details of the license plate recognition system are presented in Section 4.

3. A Survey on the Determination of Consumers Needs

In the study, before proposing the smart billboard for shopping malls, system need analysis was realized. In this concept, a shopping mall service expectation questionnaire was conducted. The findings of the study showed that consumers would be pleased with the existence of a system offering personalized campaigns and advertising messages at the entrance of a shopping mall. This finding suggests that the smart billboard to be developed for shopping malls will be functional for both businesses and consumers.



3.1 The Methodology of the Study

In the study, a questionnaire was used to reveal the expectations of consumers from a shopping mall. Questionnaires were distributed and collected from January 4, 2020, to March 5, 2020, in Ankara, Turkey. Face to face survey was conducted. The questionnaire was given to 100 people who prefer shopping malls frequently. In the study, 100 usable and valid questionnaires were obtained.

The questionnaire consists of two parts. In the first part, there are 5-point Likert Scale questions created to determine the level of participation of consumers regarding various statements. In the second part of the questionnaire,there is an open-ended question created to learn consumers' thoughts about the billboards at the entrance and parking areas of shopping malls.

3.2 Research Findings

In the first part of the questionnaire, the participants were asked to evaluate and answer four statements presented to them. According to the answers given in the first part of the questionnaire, the following findings were obtained:

As shown in Figure 2, while 45% of the respondents argued that a shopping mall should make the consumer feel special, 26% said that they disagree with this statement.

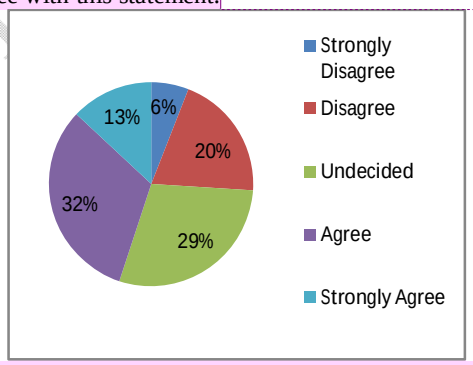


Fig. 2. Statistics related with the question of “I want the mall to make me feel special”

54% of the respondents stated that they would like to have a system in the shopping mall that recognizes consumers from their license plates and offers personalized advertisements and campaigns. However, 13% of the respondents answered this question as undecided (Figure 3).

Fig. 3. Statistics related with the question of “I would like to have a system in the shopping mall that recognizes me from my vehicle license plate and offers me personalized ads and campaigns”

According to the another finding of the survey,

Comment [RS4]: Typo

Comment [RS5]: Typo

29% of the respondents stated that they could share their license plates with the store where they shop to benefit from a system offering personalized advertisements and campaigns. Moreover, while 7% of the respondents answered this question as strongly agree, 17% answered as strongly disagree. (Figure 4)

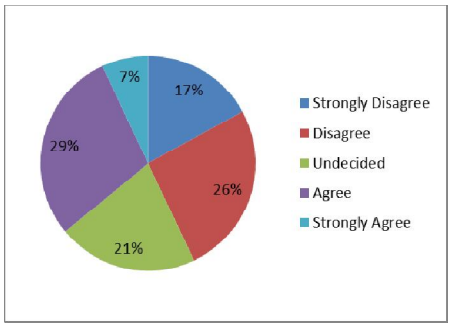


Fig. 4. Statistics related with the question of "In order to benefit from a system that offers personalized advertisements and campaigns for me, I can share my license plate with the store where I shop"

37% of the respondents stated that they would prefer the shopping malls where they use a system that provides them personalized advertisements and campaigns, while 10% answered this statement as strongly disagree (Figure 5).

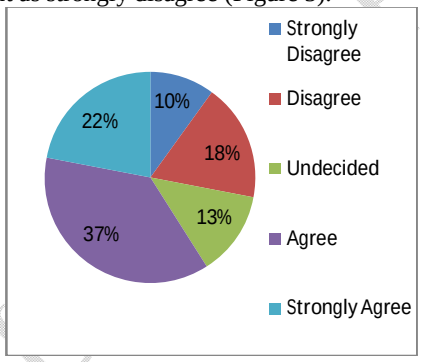


Fig. 5. Statistics related with the question of "I prefer the mall that uses a system that offers personalized advertisements and campaigns for me more than others"

In the second part of the questionnaire, an open-ended question was directed to the participants. In this context, the participants of the survey were asked about their opinion related to the billboards at the entrance of the shopping malls and the parking lot. Among the answers given to this question, "being remarkable", "I'll stop by that store if I'm interested", "memorable", "see discounts and turn to that store immediately" can be listed as the most prominent answers.

4. Development of License Plate Recognition based Personalized Billboard System

4.1 Conceptual Framework

The proposed conceptual idea is illustrated in Figure 6. In the foreground process, a hypothetical smart billboard system is set up at the entrance of a shopping mall. A camera captures the license plates of the cars entering the shopping center.

Fig. 6. Hypothetical setup

In the background process, a sequence of steps is performed (Figure 7). After acquiring the license plates, a sophisticated image processing stage is applied. The license plates in textual forms are generated and sent into a database. The past shopping records of the customers are searched in the database according to their license plates. If any match is found, a related advertisement picked up from an ad pool is presented in the smart billboard system.

4.1.1 License Plate Detection and Recognition

As a first step, License Plate Detection (LPD) is performed. To do that a series of image processing operations are applied with the following sequence:

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- R-G-B to Gray Scale Conversion
- Noise Removal
- Horizontal and Vertical Edge Analysis
- Probable Plate Determination
- Geometric Correction

- Connected Component Analysis

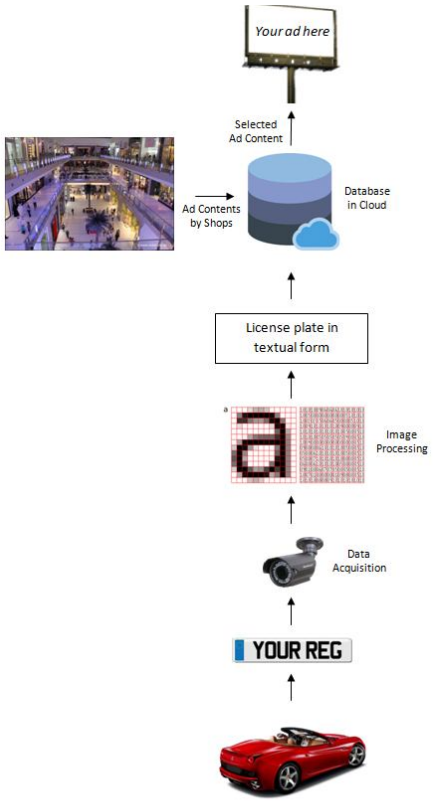


Fig. 7. Background data processing pipeline

The acquired license plate images in Red-Green-Blue (R-G-B) format are converted into grayscale and then, a Gaussian noise removal stage is applied using Matlab's image processing toolbox functions. The formula for R-G-B to grayscale conversion is given in Eq. (1).

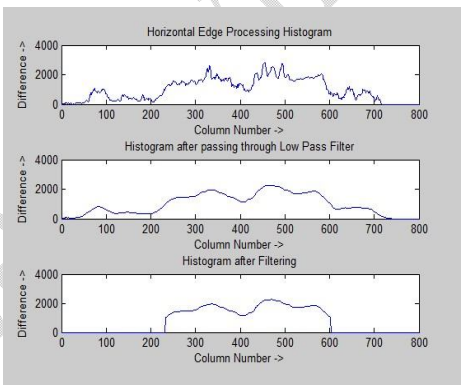
$$GrayScale = R*0.2989 + G*0.5870 + B*0.1140 \quad (1)$$

where R, G, and B correspond to red, green, and blue image planes, respectively. Besides,the Gaussian kernel for noise removal is given in Eq. (2).

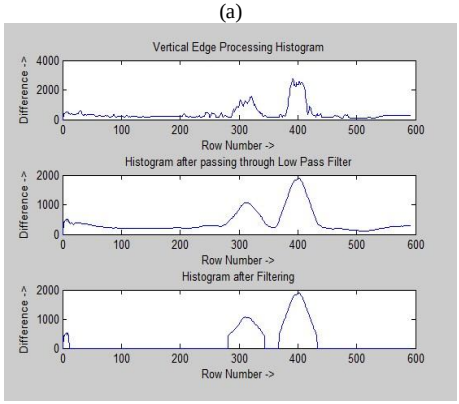
$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{\frac{-(x^2+y^2)}{2\sigma^2}} \quad (2)$$

where σ corresponds to standard deviation, (x, y) indicate the width and height of the kernel.

After that, horizontal and vertical histograms representing the sum of differences of gray values between neighboring pixels in column-wise and in row-wise are produced (Figure 8). A low pass filter is then applied to these histograms to eliminate regions with low histogram values.



(a)



(b)

Fig. 8. The analysis of edges in (a) horizontal and (b) vertical directions.

This is followed by extracting the regions with the highest probability of containing the license plate among those regions. A geometric image correction step is applied to rectify the inclination of the license plate image due to the shooting angle. Finally, the license plate is cropped by finding

the suitable connected component (i.e. the plate background in white color). The images produced during the LPD stage are illustrated in Figure 9. Note that, in this sample scenario, a fictitious plate number is used for privacy issues.

Original R-G-B image Image in Gray Scale format

Candidate plate regions Most Probable plate region

The image in Binary Format

The cropped image after connected component analysis

Fig. 9. The produced images in LPD stage

In the second step, License Plate Recognition (LPR) is carried out. To obtain the license plates in textual form, the following image processing operations are applied:

- Morphological Dilation
- Character Cropping
- Template Matching using Correlation

The cropped binary image produced in the previous step is complemented and then enhanced through morphological image processing operations. Image dilation with a 3x3 circular structuring element is applied to emphasize the characters on the license plate. The dilation of a binary image (A) by a structuring element (B) is defined as Eq. (3).

$$A \oplus B = \bigcup_{b \in B} A_b \tag{3}$$

where A_b is the translation of A by b.

Comment [RS7]: Should be clear about the algorithm

Then, the characters are cropped by using the region properties of the binary image. To do that Matlab's 'regionprops' function was employed [19]. Next, the characters on the plate are identified by template matching. In this respect, a correlation coefficient, r, is computed by comparing the extracted characters (A) with the characters previously generated (B) (Eq. (4)).

$$r = \frac{\sum_m \sum_n (A_{mn} - \overline{A})(B_{mn} - \overline{B})}{\sqrt{(\sum_m \sum_n (A_{mn} - \overline{A})^2)(\sum_m \sum_n (B_{mn} - \overline{B})^2)}} \tag{4}$$

where $\overline{A}$ and $\overline{B}$ are the mean values, *m* and *n* are the dimensions of the image.

The images produced during the LPR stage are illustrated in Figure 10. All these operations are implemented in the Matlab programming language.

Image complementation and morphological dilation

Character cropping

```
94NF6903
99BFK56
96SYK897
...
...
...
```

The recognized characters

Fig. 10. The produced images in LPR stage

4.1.2Database Association

According to the background data processing pipeline (Figure 7), after acquiring the license plates in textual form, they are sent to the database system. With the transactions made in the database

system, target advertisements suitable for the customer whose license plate is recognized are sent to the billboards. The database system and tables to be used for determining target advertisements are explained in this section, moreover, the steps to be used for determining target advertisements are presented using relational algebra expressions.

The system designed for the target advertisement problem is based on relational database principles. The system is represented by a total of 7 different tables: (i) **Customer**, (ii) **Order**, (iii) **Store**, (iv) **Staff**, (v) **Order Item**, (vi) **Product**, (vii) **Category**. While **Customer**, **Order**, **Order Item**, and **Product** tables have a key role for the target advertisement problem; **Store**, **Staff**, and **Category** tables are included in the system to ensure the integrity of meaning. The tables of the proposed database are shown in Figure 11.

The **Store** table includes information about the store. Every store has a store ID, name, phone and e-mail contact information, and an address. The table of **Staff** contains important staff details including staff ID, name and surname. This also includes information such as e-mail and phone contact. A staff operates in a store defined by the value in the column of Store ID. A store can have one or more staffs.

The table of **Product** stores details of the product, such as product ID, title, brand, category, quantity, price, description, picture, information on whether the product is new, and information on whether the product is discounted. Also, each product belongs to a category specified in the column Category ID. The table of category stores categories of the products. There might be zero or more products in each group, too.

Customer table stores information about customers including customer ID, name, surname, address, phone, email, and plate. The table of **Order** stores information on the sales order including order ID, customer ID, order status, order date. This also stores information about where the sales transaction (store) was made, and who made this (staff).

The table of **Order Item** collects the line products in a sales order. Every line item pertains to a sales order listed in the column of the Order ID. A sales order line item contains the quantity and price of the commodity, the order. It also stores the information on where the sales transaction order ID and item ID.

Constraints are applied to the database for the database to work more effectively and to ensure data integrity. The two most common of these constraints are the primary key, which provides the authenticity of the records in the tables, and the foreign key, which provides the link between the tables.

A primary key is a field or a group of fields that distinguish each row in the table in a specific way. A primary key should provide unique values and should not be NULL values. The primary key is the key information that ensures that the records in each table are unique.

To ensure this authenticity, store ID and staff ID are used as primary keys for **Store** and **Staff** tables, while the prime key is selected as product ID and Category ID for **Product** and **Category** tables, respectively. Similarly, in the **Customer** and **Order** tables, the primary keys are Customer ID and Order ID. At the **Order Item** table, authenticity cannot be achieved with a single key, to overcome this situation, Order ID and Item ID work together as primary keys.

A foreign key is a field or group of fields in onetable which identifies a row in another table, uniquely. The aim of the foreign key is to guarantee the data's referential integrity and meaningful link between tables. To enforce the link between data in the **Order** and **Customer**, **Order** and **Store**, **Order** and **Staff**, **Order Item** and **Order**, **Order Item** and **Product**, **Staff** and **Store**, **Category** and **Product** tables, foreign keys were established.

In this context, while the connection between the **Order** and **Customer** tables is established with the customer ID foreign key, and the connection between the **Order** and **Store** tables with the store ID foreign key, a staff ID foreign key has been placed between the **Order** and **Staff** tables.

While the connection between **Order Item**

Comment [RS8]: Need explanation about the method and algorithm used to check the match of plate with database recorded

and **Order** tables is provided with the order ID foreign key, the connection between **Order Item** and P**roduct** tables is established with the foreign key of product ID.

Similarly, **Staff** and **Store** tables are linked with the store ID foreign key, while the **Category** and **Product** tables are associated with the category ID foreign key.

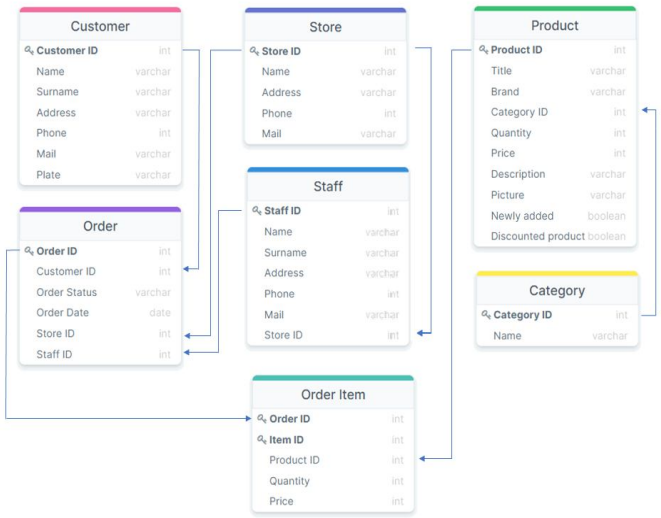


Fig. 11. Proposed DB's tables

How it works?

In this section, the working principle of the database is explained. When the plate belonging to the target customer is detected, this plate is sent to the database. Afterward, this plate is searched in the system to find out which customer belongs to and the category information of the products that the relevant customer has previously purchased is obtained. Newly added or discounted products in these categories are sent to the billboards for the target customer.

The relational algebra expressions expressing the working principle are included in Eqs. (5)-(11). Accordingly, the expression in Eq. (5) is aimed at identifying the target customer by matching the customer plate in the customer table in the database with the plate defined by cameras.Using the expression in Eq. (6), the order information previously made by the target customer is accessed. Based on the order information obtained, by using the expression in Eq. (7), the product ID of the products purchased in the relevant order is collected, and all information of the products received with the expression in Eq. (8). The category information of these products is obtained with Eq. (9). If the newly added or discounted products identified using Eq. (10) are in the same category as the products that the target customer purchased in their previous orders revealed by Eq. (11), they are called target products for advertisements. The pic-

tures of those selected target products are sent to the billboard system to be shown to the customer.

$$\rho\ (TC, \sigma_{Customer.plate = <recognized\ plate>}(Customer)) \quad (5)$$

$$\rho\ (PO, \sigma_{TC.Customer\ ID = Order.Customer\ ID}\ (TC \bowtie Order)) \quad (6)$$

$$\rho\ (POI, \sigma_{PO.Order\ ID = Order\ Item.Order\ ID}\ (PO \bowtie Order\ Item)) \quad (7)$$

$$\rho\ (PPP, \sigma_{POI.Product\ ID = Product.Product\ ID}\ (POI \bowtie Product)) \quad (8)$$

$$\rho\ (TCat, \sigma_{PPP.Category\ ID = Product.\ Category\ ID}\ (PPP \bowtie Product)) \quad (9)$$

$$\rho(PP, \sigma_{Product.Newlyadded="True"\ or Product.Discounted="True"}(Product)) \quad (10)$$

$$\rho\ (TP\ for\ Ads, \sigma_{TCat.Category\ ID = PP.\ Category\ ID}\ (Tcat \bowtie PP)) \quad (11)$$

Where TC, PO, POI, PPP, TCat, PP, and TP stand for Target Customer, Previous Order, Previous Order Items, Previous Purchased Products, Target Category, Potential Products, Target Products, respectively. The ρ, σ, ⋈ expressions used in the relational algebra equations represent renaming, selection, and natural join operations, respectively.

5. Results

In this section, the performance evaluation, and empirical results of the automated license plate recognition for the proposed Smart Billboard System for Shopping Malls to Personalize Advertisements will be elaborated.

5.1 Performance evaluation

In this study, an accuracy method used to measure the performance of the recognition rate is based on objective assessment. The number of errors can be defined as the sum of cases that do not match the correct character on the license plates, such as incorrect character prediction, missing character prediction, and plates that cannot be predicted at all. The accuracy of this problem can be defined as Eq. (12).

$$Acc = [(n - m) / n] * 100 \quad (12)$$

Where n and m refer to number samples and the number of errors, respectively.

5.2 Empirical Results

The results obtained from the application for the license plate recognition problem developed for the Smart Billboard System for Shopping Malls to Personalize Advertisements proposed within the scope of this study are given in Table 1. According to this, it can be observed that it has an accurate prediction percentage of 90%. While the error rate is 10% in total, 2% of this rate is obtained due to the fact that the plate is not recognized at all, and 8% is due to incorrect character prediction. The most common error in recognizing incorrect characters is guessing the character that is actually ‘D’ as ‘0’. Another mistake with a high prevalence is that the character that is actually ‘B’, which is recognized as ‘8’. In addition, false predictions were observed for multiple characters within the same license plate. When the predictions were examined, it was observed that the digits were generally recognized correctly, and most of the errors obtained were based on letters.

Table 1- Performance of license plate recognition system developed for A New Tool for Personalized Advertising in Shopping Malls: A Smart Billboard System

Correctly recognized	90
Incorrect character prediction	8
Cannot be predicted at all	2

6. Conclusions

In recent years, there has emerged a strong rivalry among the businesses, along with the differences in consumer preferences. Decision-makers in the companies have started to plan new marketing strategies according to the needs and expectations of the target markets. Businesses have started to create their marketing mixes with a focus on value. At this point, personalized marketing is one of the most powerful ways of creating customer interest. In other words, personalized marketing is the easiest way to appeal to target customers and markets. Basically, personalized marketing strategies aim to deliver customized products and services to the consumers. Hence, it attracts the attention of many businesses. By means of personalized marketing, it can be easier to respond more efficiently to consumers' unique needs. In this paper, based on the survey results conducted by the authors, a smart billboard system focused on personalized advertising is proposed. To ensure this, a hypothetical smart billboard system is installed at the entrance of a shopping mall. A camera-based system recognizes the car license plates by using image processing methods. A database links the license plates registered to the customers. The screen shows appropriate advertisements to the customer if any match is made.

By this system, a novel personalized marketing approach has been developed by recommending products according to the past shopping habits of the customers.The success rate of the camera-based license plate recognition system developed for the proposed approach is 90%. It was ensured that the determined target customers were shown the discounted or new products in the same category that they purchased in their previous shopping experiences. These customers were also encouraged to continue their shopping. Although the products proposed in this study are limited to newly released and discounted products in the same category, future studies will be supported by a relevant products table to be added to the dataset and a decision support system trained by experts. In this way, more accurate advertisements will be shown to target customers.

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