An Attentive Digital Signage System

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Abstract: The conceptual architecture and prototype presented in this article aims to transform standard digital signage networks to more flexible, customer-attentive advertising systems by rapidly adjusting the content displayed on each signage to online contextual data such as environment (i.e., store location, date, and time) or customer characteristics (i.e., gender, behavior). The proposed architecture encompasses a knowledge discoverer in order to reveal hidden patterns in customers' reaction to advertisements. This mechanism enhances the fit between the content presented on each signage and the interests of individual customers.

1 Introduction

In a 2007 research report by Frost and Sullivan [FS07] covering the global digital signage market, the current market of digital signage is estimated with over US$800 million dollars and is growing fast, with a projected market of US$3 billion by year 2011.

In the same report, the authors claim that "Although GRP[1] ratings, traffic details, impressions and others can be statistically aggregated; it still does not provide any insight into whether the viewers found the messages engaging and influenced them in their purchasing decision. It is in this context that the interactive and highly dynamic nature of the digital signage medium can play a crucial role. In a shift in mentality from buying advertising air times well in advance, digital signage offers media planners the flexibility to buy their slots at short notice and fine tune their content to respond in real time depending on the audience demographic".

[1] Gross Rating Point. A standard of advertising impact. The percent of the target market reached multiplied by the exposure frequency.

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Due to the aforementioned drawbacks, digital signage deployments are likely to be underutilized and not yield their full marketing potential. In this document we present a customer attentive signage system which attempts to address the aforementioned drawbacks.

2 System Architecture

Assume a retailer operating a standard advertising/merchandizing system with a back-end - module which maintains digital content such as advertisements, product specifications, and campaign statistics. The back-end module is linked to a display manager in charge of devices such digital signage displays, cameras, kiosks, and projectors deployed on the retailer's store premises. The presentation manager retrieves and presents the aforementioned content to walk-in customers based on a predetermined, rigid schedule.

The new system proposed in this document aims to transform the aforementioned solution to a more flexible, customer-attentive advertising system, thereby enabling tailored advertising, statistical analysis, and experiential learning. By describing the architecture and several usage scenarios we show how the proposed system addresses drawbacks listed in section 1.

Figure 1 illustrates the proposed system's architecture. The system comprises of a front-end and a back-end tier:

1. The front-end tier operates at the store premises and comprises of: sensors (hardware), input interpreters (hardware & software), a display manager (hardware & software) and a display screen (hardware).

1.1. The sensors are responsible for collecting data on customer's behavior and characteristics. These sensors can employ various technologies, including among others: cameras, microphones, keyboards, mice, touch pads, RFID, Infra-Red, Bluetooth, etc.

1.2. The input interpreters analyze the raw input captured by the sensors and produce an interpretation of the raw data (e.g., a face recognition algorithm may analyze a photo obtained from a camera and calculate the number of faces in the photo and their relative location). Input interpreters may contain among others: motion detection algorithms, face recognition algorithms, gesture tracking algorithms, gender recognition algorithms, age recognition algorithm, accessory recognition algorithm, voice recognition algorithm, gestures recognition algorithm, etc.

1.3. The display manager is responsible for determining what to display on the screen based on current customers' data and environmental data, subject to inferences employing earlier experiential knowledge and schedule constraints by the advertisers. As a case in point, if it is known that an aftershave is a product purchased by men, and the current viewer is a man, the display manager might decide to display the aftershave advertisement at this time. Later on the display manager needs to update the advertisements DB with the advertisements played and the statistical DB with the recent customers' data.

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2. The back-end tier serves multiple stores and comprises of: an advertisement DB (hardware & software), a statistical DB (hardware & software), a statistical analyzer (hardware & software), a knowledge DB (hardware & software) and a knowledge discoverer (hardware & software).

2.1. The advertisements DB contains among other: digital audio-visual content (clips) to be displayed, the broadcasting schedule for a network of signage devices (i.e., which advertisement should be depicted at each location, and a minimal number of impressions), as well as a real-time log storing data on which commercial was already played, where, when, and for how many times. This log serves as a proof of broadcasting advertisements and is used for billing the advertisers.

2.2. The statistical DB maintains among the rest the number of people that were in the store, the number of viewers, demographical classification of the viewers, age, time and date, reactions of the viewers to different advertisement, etc.

2.3. The statistical analyzer runs in batch mode, analyzing data from the statistical DB in order to produce statistical reports for the local store's administrative staff.

2.4. The knowledge DB maintains known knowledge about customers' behavior. The source for this knowledge may be automatic as an output of the knowledge discoverer or manual by an employee.

2.5. The knowledge discoverer runs in batch mode analyzing data from the statistical DB in order to discover patterns in customers' behavior (i.e., men in the age of 25-30 prefer to buy aftershaves in the morning and perfumes in the evening). This can be implemented by incorporating standard data mining algorithms and software packages.

The general flow of control in the front-end (store premises) is as follows (Figure 1):

F1. The sensors collect customers' data.

F2. Collected data is being analyzed by the input interpreters.

F3. The online data (captured from customers' behavior and environmental context), together with previous knowledge acquired from the knowledge DB, and the advertisements constraints retrieved from the advertisements DB are then forwarded to the display manager.

F4. The display manager decides which content is most appropriate to display on the screen and when, in congruence with the aforementioned inputs.

F5. The display manager updates the statistical DB with the latest customers' and environmental data.

F6. The display manager updates the advertisements DB with the recently played advertisements.

Meanwhile, in the back-end (control center) the following processes may be executed:

B1. The statistical analyzer analyzes the statistical DB in order to produce statistics reports for the local store's administrative staff

B2. The knowledge discoverer mines hidden patterns in the statistical DB and updates the knowledge DB accordingly.

B3. An employee updates the knowledge DB based on his or her knowledge.

B4. An employee updates the advertisements DB with new advertisements, schedules and constraints.

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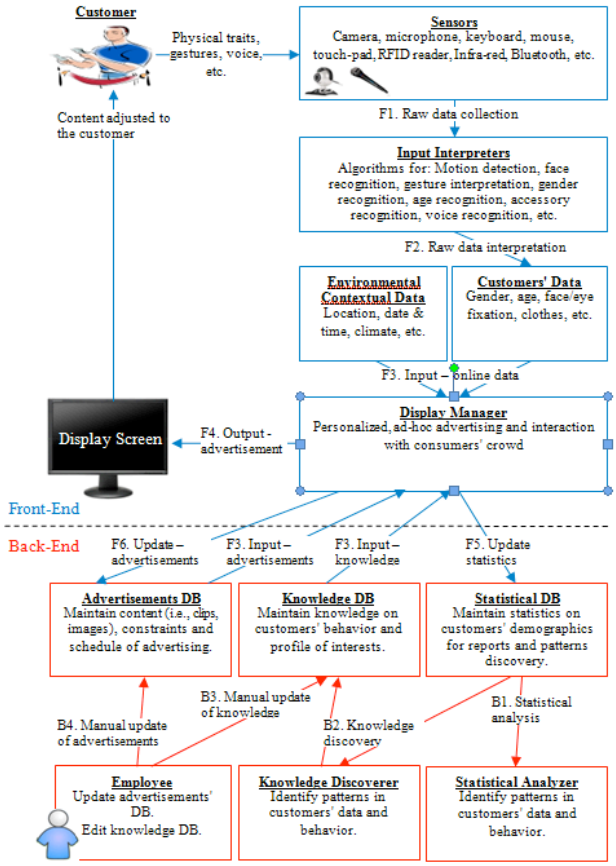

Figure 1: System architecture: F1-F6: Front-end activities and B1_B4: Back-end activities

3 Online Data

The main contribution of the system is in rapidly adjusting the content being played on a network of signage devices according to online contextual data. Online contextual data comprises of two main categories of data: Environment data and customer data.

1. Environmental data includes all non-customer specific data such as the location of the store (e.g. a store located in a poor neighborhood should try and sell low-cost products), the time and date (e.g. people buy more in the evening since they work during the day, weekends are usually better for sales in suburb branches), and the climate (e.g. people might not get out of their house in a stormy day).
2. Customer data (illustrated in Figure 2) is probably the most important input of the proposed system. Maintaining a collective customer profile ("dossier") for different types of customers (i.e., adult/teenager/child etc.), and analyzing crowd characteristics can assist in pinpointing the content depicted on the signage specific customer's needs. Each customer's data may be categorized into passive and active.

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2.1. Passive data contains all data collected about a customer that does not require an action from the customer. This includes first and foremost understanding the existence of customers. Standard methods to be applied include image-processing, motion and heat detection. Whenever a customer is identified we would like to acquire as many details as possible about him or her. This data can be classified to either customer's inherent physical traits or accompanied accessories.

2.1.1. The customer's physical traits include all details we can acquire by looking at a customer's static image including among others: gender (e.g. aftershaves are targeted to men), age (e.g. younger people are more limited in budget), race (e.g. dark-skin people may be interested less in sun-guard products), height & weight (e.g. tall men play basketball), hair & eye color (e.g. offer blue lenses for dark-eye women).

2.1.2. Accompanied accessories include all objects that a customer has or wears which are not a part of his body such as: clothes (e.g., offering a business cell phone for a person who is wearing a suit), jewelries (e.g., offering similar earrings for a girl who is wearing only a necklace), glasses (e.g., offer a free optometrist check when trying or wearing a new pair of glasses), bags (e.g., offer a new laptop in a trade-in deal if the bag carries a laptop), cell phones (e.g., offer the new Nokia N96 if the customer has the previous model N95).

2.2. Active data contains all the data we can collect about customers due to actions they perform while at the store. This data can be classified as implicit or explicit.

2.2.1. Implicit active data includes data collected on customers' behavior unobtrusively. Note, that passive data collection is also unobtrusive but does not require any actions. A good example is assessing the fixation of a customer according to the direction he is looking (face and eyes angles). Another example is analyzing a customer's reaction to an advertisement by his emotions (e.g., smiling, laughing, body language, angry voice, etc.). A third example includes capturing data on the "behavior" of a customer while at the store over a period time (e.g., route in the store, time spent next to products).

2.2.2. Explicit active data can be seen as representing interaction with a customer. A good example is a customer which picks up a cell phone from a showcase, the system can understand that the customer is interested in this cell phone and automatically depicts details on this cell phone on the screen. Another example may include a direct communication of the customer with the system using gestures (e.g. moving his hand right means go to the next advertisement), voice (e.g. show me Nokia N95), or touch. A different example is surveying the customer by the system (for supplementing the statistical DB).

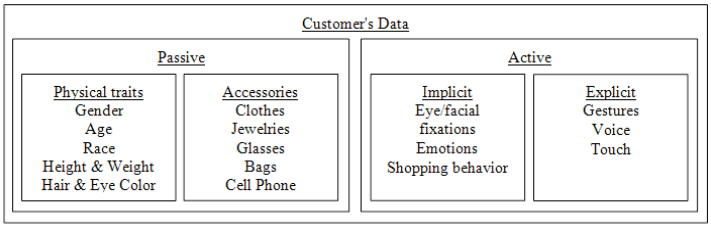

Figure 2: Taxonomy of Customer Data.

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4 A Usage Scenario Example: An Attentive Cell-Phone Store

The system (Figure 3) comprises of: 1) A front-end and 2) A back-end. The front-end comprises of: 1.1) A screen, 1.2) A showcase of cellular phones, 1.3) Two cameras, 1.4) A computer running a dedicated software for: 1.4.1) Face recognition, 1.4.2) Gender recognition, 1.4.3) "Pick-up" recognition and 1.4.4) Display managing. The back-end comprises of: 2.1) A statistical DB, 2.2) A clips DB and 2.3) A Statistical analyzer.

The system default state is "attractive mode" in which it plays a preview of each cell-phone clip in a loop. If a cell-phone is picked-up (can be identified by camera #2 and a "pick-up" recognition algorithm), the system plays its associated clip. If at least one customer is watching the screen (can be identified by camera #1 and a face recognition algorithm), the system plays the whole clip currently being played (not only the preview). When the cell-phone are returned back to showcase, and no more customers ar watching the system returns to "attractive mode".

In the background, the statistical DB is updated with data collected about the customers in the crowd (number of customers watching, watch times, genders), and the clips that were actually played. Once in a period (i.e., weekly), the statistical analyzer processes data from the statistical DB and sends the reports to the store manager.

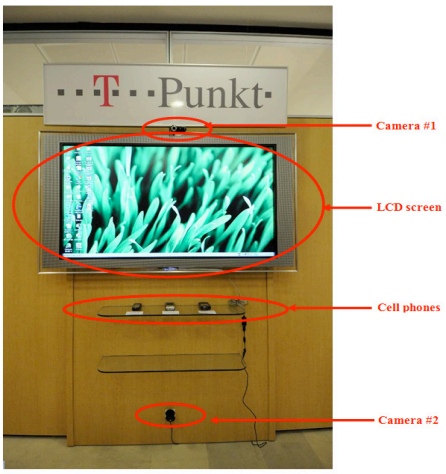

Figure 3: An attentive cell-phone store.

Bibliography

[FS07] Frost & Sullivan: World Digital Signage Markets. 2007. Report #N27B-77, available from www.frost.com.

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