Shopmobia: An Emotion-Based Shop Rating System

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Shopmobia: An Emotion-based Shop Rating System

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***Abstract*—this work proposes a system for rating shops and for monitoring the cell phone-based emotion responses of customers in a shopping mall environment. To measure customer satisfaction in a shopping environment, a mobile, non-intrusive and comfortable wearable biosensor is used to measure the Electrodermal Activity (EDA) of the shopper. The users' proximity to the store is detected using NFC tags that report to the custom application on the mobile phone. The custom emotion recognition software analyses these streams of data in real-time and associates emotion levels to each event. The aim of this project is to demonstrate the possibility of using pervasive affective computing to explicate consumer behavior towards the stores in shopping malls. By triggering positive emotions through enhancing services and improving advertising campaigns, retailers can trigger positive emotional states, which ultimately contribute to a positive and memorable shopping experience.**

Keywords—Mobile Sensing, Pervasive Computing, Affective Computing, Electrodermal Activity, Neuro-Marketing.

I. INTRODUCTION

The joy and instant gratification felt when browsing through physical shops is irreplaceable for some customers. Emotions play an important role in our judgment, perception, learning and many other related cognitive functions. Emotions also have a considerable effect on our day-to-day decision-making and our reactions to stimuli. Upon entering a shopping environment, consumers might experience a vast array of emotions ranging from, for example; excitement, joy, interest, and pleasure, through to anger, surprise, frustration, or even arousal [1].These emotions can affect the physiological state of the consumers and result in noticeable variations in bodily arousal [2].

A shopping mall may be said to be the contemporary incarnation of the marketplace, it is often made up of a collection of retail stores, services, food outlets, and leisure-based activities. The shopping mall is a place where urban citizens can enjoy, and have the ability to physically shop in a marketplace containing a diverse range of products all within the confines of a modern indoor setting.

In today's retail settings, mere customer satisfaction with a purchased object isn't sufficient anymore, a bond with the brand needs to be developed. The current trend within sales and marketing is to create a durable and personal relationship between customers and brands. It is not only the brand that the relationship has to be made with, but the retail environment itself has to be pleasant, warm, cordial, welcoming and attractive. Its design needs to be focused upon the creation and development of memorable customer experiences. The ability to measure customer arousal, in and around a particular store can help us evaluate and understand the role that these emotional responses might play in influencing shopping behaviors.

In this project we measure the physiological changes of the consumers based around a series of shops located in a shopping mall environment. The data that was collected from a large number of users is aggregated and clustered in order to come up with a rating index that represents the customer satisfaction level in a particular store.

Mobile sensing technology [3] was key to these experiments, since mobile phones are widely available and pervasive affective sensor technology has been developed with wireless capabilities [4]. Identification and access sensors such as Near Field Communication (NFC) tags are also on the increase, particularly in shopping environments. Many mobile phones are already equipped to communicate with this short-link technology. Our intention is to use the NFC tags as proximity sensors, which will easily and reliably mark a consumer's presence near a particular shop. This is a new area of research in relation to the use of NFC tags and their associated application.

The results will be made available to customers and shop owners, in similar fashion to Tripadvisor[1] and booking.com[2]. Emotion signatures taken close to the stores will be available on a recommender application, available via both mobile and on a web-based service. The idea of physically labeling and rating shops may be seen to influence in-store behavior and impact the outcomes of the interpersonal and dyadic nature of the retail services, leading to better and more satisfactory retail service provision.

The remainder of the paper is organized thus: Section 2 gives a background to the research, based on related works in the fields of emotion monitoring and Neuro-Marketing. Section 3 then presents the main research concepts for developing *Shopmobia,* including the system design. Section 4 presents

[1] http://www.tripadvisor.com/
[2] http://www.booking.com

details on the system deployment, data collection and aggregation and presents the preliminary results of the study. We conclude by summarizing the research issues relating to the study and by describing future and ongoing work in sections 5 and 6.

II. RELATED WORK

For decades, marketing research methods have aimed to explain and predict the effectiveness of advertising campaigns.

Since emotions are strong mediators of how consumers process messages, being able to understand and model cognitive responses to advertising and in-store selling has always been a challenge.

For instance, researchers have primarily relied upon the consumers' abilities to report how they feel about a particular advertised product, either in a confidential setting such as a face-to-face interview, surveys, or in a group setting such as a focus group [24]. Unfortunately, these methods have considerable limitations. Firstly, they assume that people are actually able to describe their own cognitive process which we now know has many subconscious components. Secondly, numerous factors motivate research participants and can distort the reporting of their feelings. These include incentives, time constraints and even peer pressure.

In addition, empirical studies in real-world shopping environments have shown the usefulness of pervasive computing technology in physical shopping experiences. Many researchers have analyzed customers' trajectories in shopping environments. For example, Takayuki Kanda et al., [5] developed a technique to distinguish window shoppers from busy commuters; Chuang-Wen You et al. [6] devised a pervasive system to sense physical shopping activities while tracking shopping time at physical stores. Meschtscherjakov et al., [7] proposed a prototype display that depicts dynamic visualizations of customer activity in a retail store on a conventional map.

While shopping, contemporary customers want more than just a traditional shopping - see and buy - experience. They are searching for an experience that combines leisure and entertainment. Researchers and store managers increasingly acknowledge the importance of the store environment in shaping a customer's emotions, thereby creating a memorable experience of the store. This puts more pressure on retail stores that want to stand out from their competitors and create a unique and enjoyable shopping experience [8].

Past research in retailing has found that the specific characteristics of stores, most notably "appearance, décor, product assortments, location, service quality and store atmosphere" affects consumers' store evaluations and shops choices [9] [10].

In the emotional shopper study [11] the authors look for the shoppers' emotions by tracing their faces. They believe that facial recognition can give a clearer indication of the customers' affective state than self-reporting can. The study took place in a big supermarket that contained: an electrical store; DIY store; household goods; and so on. During the course of the study, the authors attempted to find the hot spot in the supermarket, i.e. a place that contains the most positive emotion, and this led them to conclude that "*more happiness is more satisfaction with the brand*".

Emotion is an important factor in the creation of a successful customer-retailer experience [12], with the development of the Neuro-marketing concept arising from this. Neuro-marketing is believed to remove traditional market research subjectivity. Instead of a customer reporting his opinion, neuro-marketing uses objective biological measures to assess a customer state [13]. Many big brands have already used the concept in order to develop their business and benefit from these new understandings e.g. Google and Microsoft [14].

Unlike product evaluation and Neuro-marketing systems, 'customer experiences' in stores and mall environments receive less attention. There is very little literature on how to measure and evaluate customer emotion. However, user experience modeling, in the form of store rating is indispensable for guiding the design of a retail store environment.

The interest in recognizing emotion has increased in recent years and more people are using sensors to measure bio-signals, even though in the past these have been costly. However, recently, new technological tools have emerged to allow a robust and affordable measurement [15].

The majority of previous studies have focused on studying Electrodermal Activity (EDA) in lab settings [16]. In order to understand the meaning of the EDA signal, careful experimental settings have to be followed. However, this cannot be the case in a shopping in a real-world context where it is difficult to control the environmental variables in the setting. The out-of-lab (in the wild) environment of the study poses great problems and adds noise and unexpected situations to the experiments, but also offers great opportunities in regard to understanding the issues that may impact upon a real-world design that would be used in such a context.

Outdoor, or out-of-lab measurement has been the subject of several recent studies, such as the sleeping at home experiments [17], or the "inside out" experiment [18], where users were asked to wear the EDA sensor continuously during the day or the night. Unlike our experiment time that focused upon the time spent on the task (shopping in this case) the measurement time in these studies was much longer, and can include recordings of several days and nights, due to its focus on understanding long term behavioral patterns.

To the best of our knowledge, currently no previous work has proposed the monitoring of customers' emotions toward stores using physiological sensors.

III. SYSTEM DESIGN

A. Emotion Model In Physical Environment

Mehrabian & Russell [19] proposed a model, which related features of the surrounding environment to behavioral responses. These responses were mediated by the individual's emotional states, Pleasure-Arousal-Dominance (PAD), induced by the environment. In 1982, Donovan & Rossiter implemented Mehrabian & Russell's framework into retailing and service settings [20]. Since then, the PAD framework has been widely used in marketing and consumer research.

Figure 1. Emotion flow according to Mehrabian & Russell applied to a shopping environment.

We adopt the PAD model in this work. Our physiological sensors measure the emotional reaction to shop stimuli, then our classification algorithms help in labeling the data by categorizing them into emotional traits. The resulting qualitative data aided customers and shop owners in improving shopping experiences in a form of Approach or Avoidance.

The architecture, as shown in Figure 1, involves taking steps in order to provide ultimate shopping benefits for both customers and shop owners, while Figure 2 shows the architechture of *Shopmobia* system.

In the next two sub-sections we describe the emotion monitoring and localisation techniques used in this work.

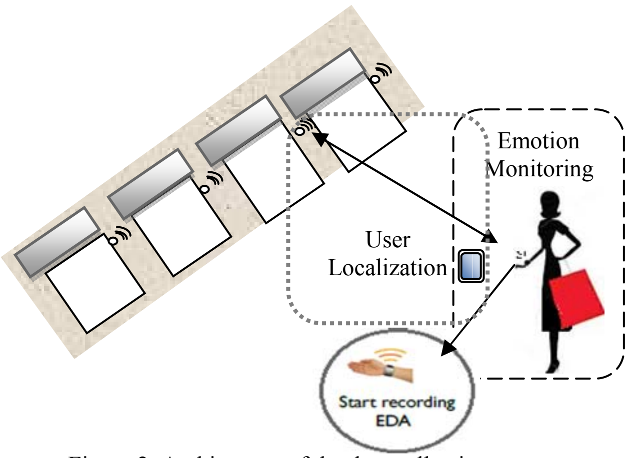

Figure 2. Architecture of the data collection system

B. *Emotion Monitoring*

To monitor emotions we used Galvanic Skin Response (GSR) sensors. The autonomic nervous system can be divided into sympathetic and parasympathetic divisions and emotion can be measured by many sensors. Emotion variation indicators like heart racing, rapid breathing, tense muscles and sweaty palms are all induced by the autonomic nervous system which controls heart muscle, smooth muscle, and exocrine glands [21]. GSR sensors, however, have the advantage of offering the best indicators of sympathetic nervous system arousal. They indirectly display the individual's mental activity by measuring the moisture level in skin. The moisture level varies when an individual is aroused, stressed or excited, causing the skin electrical conductance to change as well [16].

By monitoring the EDA, it is possible to detect periods of excitement, stress, interest and attention. For the purpose of this study, EDA is used as a proxy to understand how much a shop stimuli can positively provoke and engage customers.

For our experiments, we used an Affectiva Q-sensor[3], an Electrodermal Activity (EDA) wristband wearable sensor, that also measures skin temperature and 3 dimensional hand motions. It can be easily worn on the wrist and can measure skin conductance in a non-lab environment such as a shopping mall. Custom software was developed for the Android platform in order to store EDA and skin temperature data using an instant Bluetooth connection in conjunction with the sensor, see Figure 4.

The performance of the sensor was evaluated in [22]. Its ability to measure arousal around a particular store can help us evaluate the role emotion plays in influencing shopping behaviors outcomes and can lead to a greater understanding of the role of emotions in the shopping process.

Therefore, we started collecting data from different subjects. This data was stored in order to help in finding obvious visual patterns and also for feature extraction. Figure 3, shows the EDA data (with moving average applied) collected from one individual around one shop in a happy state (given a voucher and samples), Frustrated (with a toddler present) and relaxed (listening to music) states. The frustrated signal displays a pattern of fast changes, however the happy signal displays a phasic pattern.

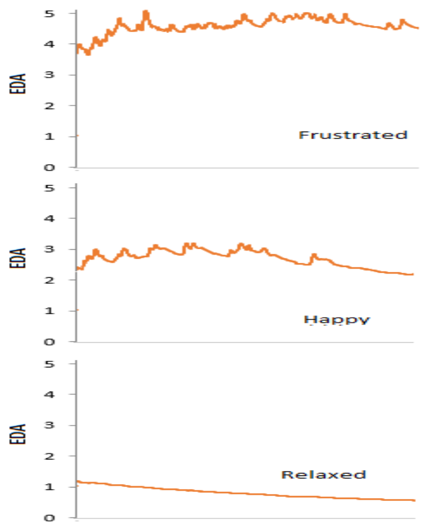

Figure 3. EDA output of subjects *Frustrated*, *Happy* and *Relaxed Localization*

[3] http://www.affectiva.com/q-sensor

Knowing when and where a detected sensing event occurred can be just as useful as what physically triggered it. In order to identify which shop the costumer is visiting, we utilized a shop identification method to suit shopping mall environment where GPS doesn't work.

Instead of using exact conventional tracking techniques such as GPS localization, camera analysis, or sensor networks, we will utilize NFC to tag user's data with the new shop being visited. Therefore, the location log relies on precise proximity information obtained through NFC tags and unlike other localization technologies; it is characterized by relatively low computational requirements and is perfectly suited to indoor environments and shops' size variance [23]. Not all smart phones have NFC chips in them. We have adopted Samsung S3 phones in particular as the main mobile platform since they are equipped with NFC. Figure 4 shows a screenshot of *Shopmobia* application.

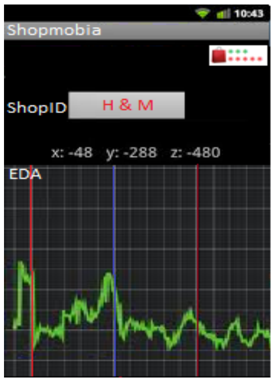

Figure 4 Shopmobia screenshot

IV. Deployment and Preliminary Results

We recruited 24 participants from two major shopping malls in Riyadh. Participants' age ranged from 22 to 50 years old. The majority of our users were women from a variety of educational backgrounds. Their occupations included housekeepers, students, teachers and professors. In our deployment, each user was asked to wear a wristband emotion sensor, to carry a mobile phone, and to proceed with their normal shopping around 10 specified stores. The map and the layout of one of the experiment areas is shown in figure 5. In this paper, we will focus on data collected in Riyadh Gallery, where 120 valid entries of location data from 12 users around 10 shops were registered. Entries from 6 other users were dismissed due to detected errors in the emotion readings and the NFC localization. While we are still analyzing the data collected from these experiments, we present in this paper some preliminary results from our experiments in the Riyadh Gallery only.

We randomly selected three well known shopping malls in Riyadh; we then selected representatives' stores and brands from these three malls from each of the major types: clothes, shoes and makeup. These malls are Riyadh Gallery[4], Hayat Mall[5] and Sahara Plaza[6]. The former are giant malls with a large collection of branded clothing, a grocery store and a spacious food court in each mall; they are seen as the one-stop entertainment and shopping environments in the city of Riyadh. We selected shops to give identical or similar brands in all three shopping malls.

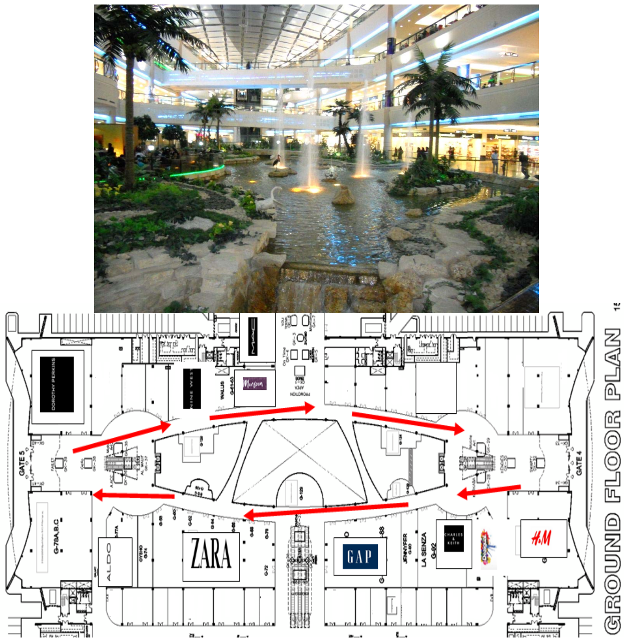

Figure 5 Riyadh Gallery mall, and ground floor plan where we deployed our system.

Before conducting the experiments, each user had to wear the sensor for a 5-minute warm-up period during which their skin conductance and body temperature increased to a plateau. A relaxation period of 10 minutes followed in order to establish a baseline setting.

Afterwards the user started shopping around the designated shops one after the other. The whole experiment took approximately 40 minutes. NFC tags registered their presences around shops which allowed us to aggregate the data according to the shop ID. We used long range (about 50 cm) NFC tags in order to allow automatic sensor data tagging without direct contact; however users were advised to walk near the tags.

Figure 6 closely shows an interesting finding in which multiple skin conductance responses (SCRs) were evident when the user was entering shoes shops. One user commented, "When she has to "size up" (buy larger) clothing in the other shops she gets depressed and feels as if she's overweight. But when she sizes up a new shoe (get a larger shoe size) it felt good". However, it is difficult at this stage to infer whether the increase in arousal is due to excitement or other factors.

[4]http://www.riyadhgallery.com
[5]http://www.hayat-mall.com
[6]http://www.saharaplaza.com

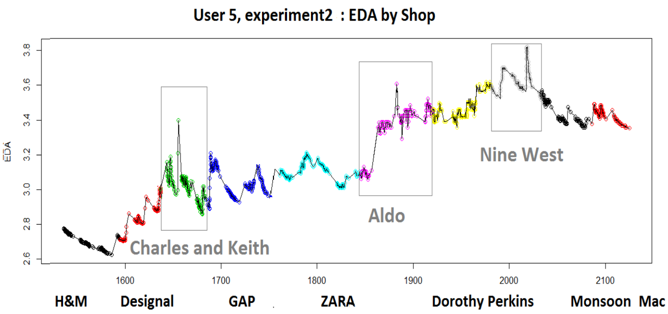

Figure 6 this graph shows the time against EDA level around 10 shops

An initial statistical feature extraction has been applied on the dataset of 6 experiments by different users around 10 shops. We can see higher levels of EDA near shops 3, 6 and 8 which are mainly shoes shops.

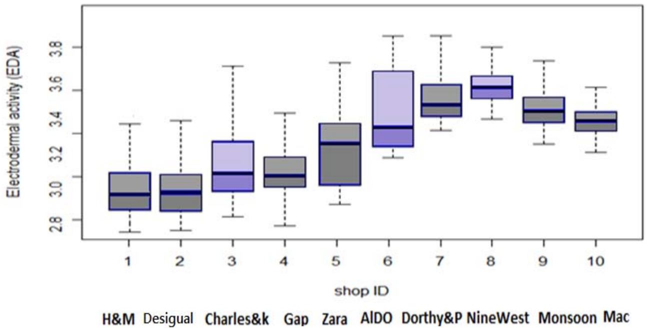

Figure 7. BoxPlot of emotions recorded around 10 shops (6 experiments per shop).

Once the data was statistically analyzed, it proved that the SCR value had direct relationship with the level of arousal.
In this project, SCR is used for emotion recognition, therefore observing the change in these values is more important than the absolute values.

V. Emotion Classification and Shop Rating

More user experiments are being conducted to produce the training set based on: 12 participants and 26 datasets in total. We then apply the running mean on each signal value in order to distinguish between phasic, fast changes and tonic, slow moving components in the analyzed signals. The extracted features from each signal will be: Standard deviation, Mean, Max, Min, Slope, first and third quartiles.

K-mean clustering will be then used as an unsupervised learning method to classify our data according to the training set.

We also define the task of inferring the emotion of a user as a supervised classification problem where we seek to learn a function f such as:

$$y_i = f(x_i)$$

Whose input is the EDA signal and output is a class label that corresponds to the inferred most prominent emotion. In other words, we exploited the quantitative emotion patterns observed through EDA in order to identify the qualitative aspects of emotions when a customer is nearby a shop. For the comprehensive analysis, we will develop and compare many scoring and updating methods based on different machine learning techniques such as Logistic regression and GMM. Also, in order to extract one emotional value that represents the measurements collected at one shop we will consider applying 2-D Gaussian distribution weighted by the residence time at each measurement. Clustering methods such as k-means are also being developed to classify each individual aggregated data.

Besides this we are also examining the concept of Emotion-based Recommendation. We can use existing recommendation algorithms for verifying the affective entity scoring framework.

In addition to studying the variability of emotion levels within a shopping mall we will look at the variability between different malls.

Our findings will be disseminated in the form of a shop rating application to demonstrate the effectiveness of the system for both customers and shop owners.

VI. Applications

As we have already written there are obvious applications for the kinds of technology that we are developing, particularly within the retail, sales and marketing sectors. Currently we have been examining the role of these sorts of technologies in regard to their use in in-situ physical settings. However we envisage that the technologies that we are developing could also be used within a co-located sales setting, which is a setting where a customer is physically in a different place, but is able to use mobile technology to browse the store and discuss purchases in a face-to-face manner (although digitally mediated) with a sales assistant. This would enable us to better understand some of the factors that make shopping in the real world different from a co-located shopping experience. We could then attempt to develop systems that supported co-located shopping in a way that made it feel better for the customer. Being able to shop in this manner would also have implications for other shops that are based outside of the mall, perhaps in rural areas. Imagine being able to buy products from the bazar or market place, and being able to enjoy the experience from the comfort of your own home.

Robotic sales is also another avenue of research that we can see evolving from this research, being able to understand people's emotional responses to robots in the shopping mall could prove invaluable, particularly in shops that could be staffed 24 hours a day, or indeed in robots that may be designed to carry out mundane tasks such as shopping. By using the evidence and datasets that we are starting to collate, one would be able to give robots the ability to react to their environment in what would appear to be a natural way.

VII. CONCLUSION

In this paper, we have presented the shop rating system based on customers' emotion. Such an experimental setup could have the potential to benefit both customers and shop owners. Using data collected from a real-world deployment, we argue that our shop rating system can effectively provide customers and retailers with systematic feedback regarding customer satisfaction and enable owners to better understand customer behaviors. In the future, we hope to scale up to larger deployments in more shopping malls and recruit more users from different backgrounds and ages.

I. ACKNOWLEDGMENTS

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