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Understanding Consumer Preferences using IoT SmartMirrors

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ABSTRACT

Internet of things (IoT) has so far been considered to be a complex network of objects speaking to each other across a digital network transmitting information and broadcasts about themselves and their surroundings through an assembly of sensors, actuators and motors. In this paper we present a use case for IoT to understand and record consumer behavior. In essence the paper attempts to classify how humans and IoT devices can learn from each other. In this paper retail smart devices can help salespersons understand more accurately a consumer or shoppers preferences and suggest more suitable options.

Keywords: Human – IoT bridge, Indian enterprises, Intelligent gesture recognition, Internet of Things, Knowledge recording, SmartMirrors

INTRODUCTION

Internet of Things (IoT) refers to the growing cyber physical development of augmenting physical devices with computing and communication capabilities to collectively gather information on real time basis (Guo, Zhang, Wang, Yu, & Zhou, 2013).

With Internet of Things as a global network allowing communication between objects-objects and objects-humans a unique identity for each and every object (Aggarwal & Das, 2012) new technology horizons have opened up.

Ferguson, T. (2002) has emphasized the importance of objects having the ability to communicate can speed up processes, reduce error, prevent theft, and incorporate complex and flexible organizational systems through IoT.

Numerous research papers illustrate comprehensively that customers' requirements play a key role in product performance in conceptual design (Häubl & Murray, 2001). The textile sector in India is one of the oldest industries in the economy contributing

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11 per cent of total exports (USD41.4 billion in 2014-15) and employing a huge population (Ministry of Textiles, Tech Sci-Research Note).

India has a sizeable chunk of millennial and is one of the biggest fashion markets and shopping trends have changed from open markets to mom and-pop stores to multi-storied shopping malls. SmartMirrors are highly functional advanced mirrors manufactured by integrating embedded electronics such as displays, cameras, and sensors. SmartMirrors offer an array of features such as Internet connectivity and some products offer touch screen option. Globally, the SmartMirror market is witnessing significant growth due to increasing demand for the SmartMirror in major shopping outlets & malls. By connecting IoT to SmartMirror, it is possible to implement a variety of application services. SmartMirror that has been linked with IoT platform is friendly and variety provides information to user (Moon, et al., 2015). The global SmartMirror market has been estimated to be valued at USD386.8 million in 2015, and is expected to witness a healthy compound annual growth rate (CAGR) from 2016 to 2022 (Persistence Market Research, 2017). The IoT powered SmartMirrors offers retailers opportunities in three areas: improving customer experience, measuring product or apparel acceptability / trials / converts, and new channels and revenue streams.

This article provides an exploratory research on the use of SmartMirrors in the retail garments shopping to determine their efficacy in influencing customer shopping and also increasing shop seller's productivity by reducing number of actual trials and identifying potential sales and non-materialized sales.

Literature Review

Bellman, Lohse, and Johnson (1999) described some factors that predict customer buying behavior. Laudon and Traver (2001) list some aspects of consumer profile to explain customer online behavior. In the context of online shopping to attract more customers' purchasing, Haubl and Murray (2001) believe that a selective recommendation agent can play a prominent role to persuade consumers' purchase decision. Their findings suggest, "An electronic agent have the potential, whether intentionally or unintentionally, to persuade users that certain alternatives are preferable to others."

Solima, Della Peruta and Maggioni (2015) has presented a strong case backed by exploratory research on using IoT devices as a visual aid for museum visitors. It has been shown that implementing IoT solution introduces a plethora of new products, services and business models for guides and cultural events.

Ceipidor et al. (2011) has explained a ShopLovers solution as tool to use interconnected objects powered by Radio-frequency identification (RFID) to enhance social connect of customers and brands which runs on mobile devices and transforms the shopping experience using Near Field Communication (NFC) and other technologies. This solution helps customers coordinate actions in a retain environment such as checking out products and making payments or referring choices to friends and ask their advice.

Ching, Yue and Lee (2016) has explained technical feasibility of developing a tele-presence robot which can adopt social expressions with facial contours and gestures. These can be used for ad-hoc conversations in offices or as a guided tour for retail shoppers.

Randelli, Bonanni, Iocchi and Nardi (2012) has explained the aspect of knowledge acquisition through interaction between humans and robots. It is argued that a robot due to their limited understanding of their surroundings restricts their capabilities and utility in real world situations. However, using speech technologies and vision based systems and established AI algorithms human skills can be learnt by robots leading to accomplishment of more tasks.

Guo et al. (2013) has demonstrated the concept of opportunistic IoT (which is a decentralized ad-hoc human centric networks e.g. customers connecting Bluetooth over a coffee shop) which is the observed close relation between human and smart objects enabling information forwarding. Information so captured by this interaction can be carried forward to other opportunistic IoT communities. Weiser (1991) prophesized that pervasive computing can learn and adapt to human needs.

IoT consists of three capabilities user awareness (personal contexts and behaviors), ambient awareness (space status) and social awareness (group level detection of patterns) (Guo et al., 2013).

METHODS

Technical Layout - SmartMirror

The proposed solution suggests the following applications of a Smart Meter in engaging customers and ensuring a higher trial to sales ratio in the case of readymade apparels (Figure 1).

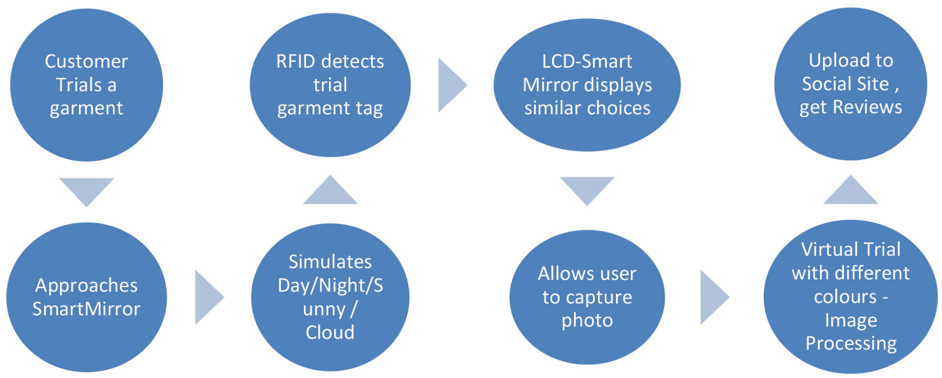

Figure 1. Process flow SmartMirror

- A SmartMirror made of acrylic or glass with adjustable lighting (two-way mirror). These mirrors allow a Liquid Crystal Display (LCD) to be fitted behind while retaining the properties of a Mirror to be used in retail trial external rooms. The mirrors have a Light Emitting Diode (LED) background lighting which can be dimmed to simulate day light, night light or cloudy or sunny environment.

- Raspberry PI device for computing power with WI-FI access and RFID tag reader. The raspberry Pi allows limited processing power; powered by a Linux OS it allows Data retrievals, image processing and content display.

- Kinect Camera for 3d Sensing and tracking user gesture, this can be for an advanced model to detect a customer's touch preferences on the mirror and accordingly simulate actions such as dimming lights for a specific selection using finger movements, simulating a like or dislike again using gestures.
- LCD display behind the Mirror for content and image display. The LCD will display matching images of similar costumes while also allowing consumers to take photographs and upload the content to their social networking sites to get reviews.
- Software for coordination and orchestration and connecting to back end inventory system. The software performs a myriad of activities including reading the RFID tag of the clothes being tried and then getting data from the back-end systems matching the tag category as suggestions. The software keeps track of user preferences and final selection to constantly give better choices and thereby increase sale converts from trials.
- RFID tags attached to the garments for identification uniquely, this allows grouping of similar tags apparels.
- Integration between social networking sites, content (Application Programming Interface, API).

The process consists of all garments being tagged with a RFID tag, the SmartMirror being enclosed in an open Kiosk, and each consumer being given a RFID card (to be used dually as a brand loyalty card). The consumer tries a ready-made garment, approaches the SmartMirror which detects the garment using the tag and the consumer identity using the card. The SmartMirror collects data of past purchases to give many upsell and cross sell ideas to the consumer through a complex algorithm consisting of his past purchase trends and the other consumer trends on same age group or profile and also the other similar options available in the store. The consumer also has an option to click a photo and upload to connected social network sites and with friends to get their opinion resulting in a higher acceptance and sale. Finally, the SmartMirror also has options to adjust lighting to give different appearance of a sunny bright day, night or evening, cloudy or winter to help users understand the clothes appearance in diverse weather conditions.

The SmartMirror gets insights with the number of customer usage and it provides a ready to use data mine for number of trials, most accepted or tried garment set and the garments which face rejection due to size or color limitations to the merchant. Thereby allowing the seller to understand the reasons for non-converted sales and work towards having a fast selling stock reducing capital lock in in no moving items.

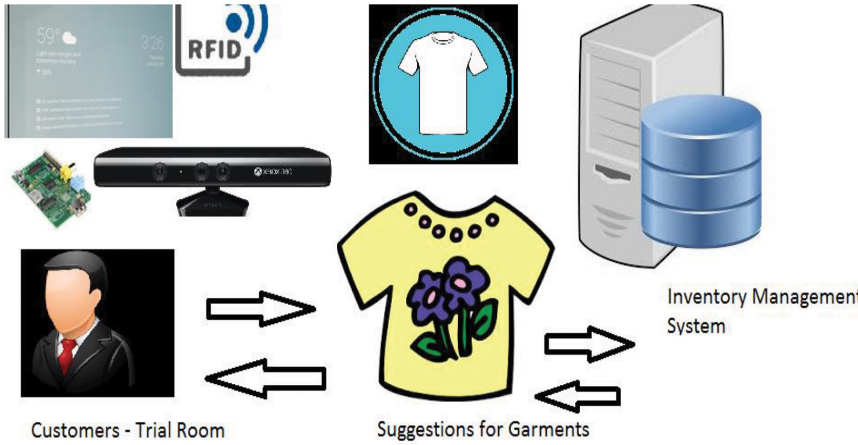

Figure 2. SmartMirror suggesting a customer

The SmartMirror can further use AI to superimpose different costumes on the person's mirror reflection there by reducing time for trials, effort in cleaning up tried garments and also pilferage or damage to clothes.

The above process helps a consumer simulate virtually based on suggestions given by the SmartMirror backed by analytics, this is a combination of machine intelligence (adaptive intelligence) and user preferences. The following analytics are of significance from customer and retailer point of view.

Consumer gets insights based on his current selection, what other consumers have purchased or liked there by providing real time insights.

Retailer gets insights on customer's preferences for each garment including his level of likes and dislikes thereby stocking more preferred items and also having a higher trial to convert ratio.

The system can be enhanced by identifying using facial recognition or a IoT wearable the exact customer approaching the Smart Meter thereby giving him a personalized offering and also keep his history of transactions and preferences in the past thereby getting valuate insights into changing trends at an individual customer level (Figure 2).

RESULTS AND DISCUSSIONS

To motivate our research, we did a secondary data analysis using literature review of existing implementation cases.

First, a high-street shop Neiman Marcus, San Francisco which has installed a Memory Mirror the major benefit to customers being a reduction in the long process of trying and retrying on clothes. The Memory Mirror shows you a 360-degree view of customers with the outfit on and allows comparing outfits side-by-side. It also snaps photos of customer with the outfit to share with friends on Facebook to ask for their opinion before making a purchase.

Second, Ralph Lauren, New York, with a SmartMirror inside the changing room, mirror is programmed to transform the lighting and also change the outfit colors and size and try out virtually using interactive touch. It also allows integration with smartphone of the helpers who can bring the desired color and size. The mirror also recommends other items which can go with the original choice. Following this a trial was conducted for limited set of respondents on whether they found the study satisfactory or value adding. Based on both of this the paper arrives at a logical conclusion.

Michelleti (2003) asserts women drive consumer activism than men primarily because they do daily shopping, they are more concerned about the impact on family and finally because they have had to work more due to historical exclusion from decision making.

To understand the premise for such as SmartMirror need, the researchers used the Observation method in a leading retail garment shop to identify on random days the pattern of buying. As part of this daily two families or individual was observed ever since they entered the shop till the time they exited and on subsequent days to eliminate bias. Observation sheets were structured and standardized It was observed after consolidating observation sheets of 25 families that:

- Clothes purchased were similar in design/ fabric to what the customer was currently wearing in other words current clothing pattern could predict buying pattern.
- Across age group clothing trends were similar or could be related logically.
- Color choices were very distinct either dark or light and it also had a bearing on one of the clothes of the purchaser or the family member.
- Lastly purchases spend over 80% of the time locating clothes of right sizing, similar design but different colors and around 20% of the time in trials
- Trials rooms on an average took almost 8-10 minutes per buyer for trying out and usually 3 sets of clothes were tried out at the same time.
- The attendants spend roughly 5 minutes repacking, restoring to original place the tried-out clothes.

The above observations could be addressed in a scientific manner using the SmartMirrors as per the researchers.

- The SmartMirror using Cognitive algorithms could predict the buyers age, current clothing sense and colors to predict matching designs and patterns
- SmartMirror algorithms could be used for virtual trails reducing the need for packing and replacing and also blocking the trial rooms for a longer period.
- Lastly SmartMirrors could serve as virtual shopping assistant thereby suggesting stocks in place in the store rather than for endless searching and not finding a matching garment.

Table 1
Descriptive statistics on sample

Age Group					
		Frequency	***Percent***	***Valid Percent***	***Cumulative Percent***
Valid	<30	32	58.2	58.2	58.2
	>30	23	41.8	41.8	100.0
	Total	55	100.0	100.0	

The researchers tied up with a SmartMirror manufacturer and the system put on trial in a controlled environment with around 55 women participants. Each participant was briefed on the technology and their responses recorded to create a clothes inventory with RFID tags. Actual evaluation was conducted and based on 6 close ended questions were presented to help review perception of the systems usability. A 5 point Likert scale was used to develop an ordinal ranking of preferences concerning the perceived utility of the SmartMirror and its contribution in and motivation in using this technology. The survey was administered in person over one week day and one week end. Descriptive statistics were calculated and there after the data was analyzed and using factor analysis it was seen if we can reduce them to one variable "buyer and seller utility". The following graphs show the descriptive statistics of this survey sample.

The descriptive statistics shows that the sample has comparable sizes on population from both age group segments below 30 and above 30.

Table 2
Measures of central tendency

Statistics						
		Age Group	***Faster Selection***	***Faster Trial***	***Better Feedback***	***More Informed on Stock Status***
N	Valid	55	55	55	55	55
	Missing	0	0	0	0	0
Mean		1.4182	3.4182	3.4909	3.9273	4.2182
Median		1.0000	3.0000	3.0000	4.0000	4.0000
Mode		1.00	2.00	3.00	4.00	4.00

We do a test for the normality of data across the two groups. Since the sig value is less than .05 hence normality of data cannot be concluded.

Table 3
Tests of Normality

	Faster Selection	Kolmogorov-Smirnovb			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	Df	Sig.
Age Group	Neutral	.417	12	.000	.608	12	.000
	Agree	.485	15	.000	.499	15	.000

a. Age Group is constant when Faster Selection = Disagree. It has been omitted.
b. Lilliefors Significance Correction
c. Age Group is constant when Faster Selection = Strongly Agree. It has been omitted.

The analysis of survey results shows that the SmartMirror has definitely resulted in a better feedback mechanism for the sellers on customer preferences and made the buyers more aware of stock after making the initial selection of different colors and designs. The results on faster trials or faster cloth selection are not very clear though it holds potential for future. Further it was shown that SmartMirrors using advanced cognitive image processing algorithms could reasonably well detect the buyers profile, current clothing and color preference, age and gender and together with a robust integration could reduce time to buy significantly, convert more trials to sales and finally reduced the maintenance for replacing tried out garments. The biggest benefit came from the less time spent in the shop thereby reducing crowd and keeping space for potential customers.

There are number of challenges in the proposed solution. Technically security can be a major challenge as more and more objects start intruding privacy and identity in a cyber-physical space. Additionally, whether the virtual simulation though gives a lot of comfort will be it fulfilling in terms of garments trials. However, this point can be mitigated as we see increasing volumes of ecommerce garment purchase just by viewing the pictures of the garment online. Ensuring number of such mirrors will also be a challenge however it is evident that the number of trial rooms though limited is able to satisfy the demand even with increasing footfalls. It needs to be seen whether the mirrors can perform myriad other revenue generating functions like advertisements or display boards when they are not in use using their wireless content broadcast and accepting architecture.

From the research aspect the small sample size may not meet population mean expectations and the questions may be too general in nature. Factors such as longitudinal effects, cultural effects, gender effects and segments such as high end designer clothes have not been taken into account and could affect research results. The earlier observation is very limited in scope and may vary for stores with attendants and with higher technology advancements. The research also suffers from limited field survey and convenience sample.

CONCLUSION AND FUTURE SCOPE

Cyber physical machines have huge potential in health care, retail, manufacturing, energy to name a few. IoT objects such as SmartMirrors have the potential to bridge the current knowledge divide between sellers and consumers especially in the case of readymade garments and track the trial of clothes and the ratio between trials and converted sales. While trials of garments give an indication of customer's purchase interest most instances trials do not convert to sales due to color issues, design issues, lack of correct sizing and fitting and thereby influencing choice decision. This paper shows how SmartMirrors can capture data on trials and reduce time spent searching for alternatives by giving suggestions intelligently or alerting support staff. Technologically IoT devices embedded in utility appliances like mirrors can help decision making and with the integration of data. In future SmartMirrors may have capabilities to recognize a prospective buyer. Integration with other social channels like social media can further add value by real time sharing of information. The trend is visible across age groups as seen from the survey results which confirms quantitatively the use of SmartMirrors and hence can be adopted to successfully replace traditional mirrors. Worldwide there are many cases of SmartMirrors implementation but there are more informative than transactional. A blended solution with instructiveness and intuitive solutions like facial recognition, speech recognition, and emotion recognition and finally preference recording and suggestions will lead to faster adoption and better customer benefits.

REFERENCES

Aggarwal, R., & Das, M. L. (2012, August). RFID security in the context of internet of things. In *Proceedings of the First International Conference on Security of Internet of Things* (pp. 51-56). ACM. New York, NY, USA.

Bellman, S., Lohse, G. L., & Johnson, E. J. (1999). Predictors of online buying behavior. *Communications of the ACM*, *42*(12), 32-38.

Ceipidor, U. B., Medaglia, C. M., Volpi, V., Moroni, A., Sposato, S., & Tamburrano, M. (2011, September). Design and development of a social shopping experience in the IoT domain: The Shop Lovers solution. In *19th International Conference on Software, Telecommunications and Computer Networks (Soft COM), 2011* (pp. 1-5). IEEE, Split, Croatia.

Ching, P. W., Yue, W. C., & Lee, G. S. G. (2016, April). Design and development of edgar-a telepresence humanoid for robot-mediated communication and social applications. *IEEE International Conference on Control and Robotics Engineering (ICCRE), 2016* (pp. 1-4). IEEE, Singapore.

Ferguson, G. T. (2002, June). Have your objects call my object. *Harvard Business Review*. Retrieved from https://hbr.org/2002/06/have-your-objects-call-my-objects

Guo, B., Zhang, D., Wang, Z., Yu, Z., & Zhou, X. (2013). Opportunistic IoT: Exploring the harmonious interaction between human and the internet of things. *Journal of Network and Computer Applications*, *36*(6), 1531-1539.

Haubl, G., & Murray, K. B. (2001, October). Recommending or persuading? The impact of a shopping agent's algorithm on user behavior. In *Proceedings of the 3rd ACM conference on Electronic Commerce* (pp. 163-170). ACM. Florida, FL, USA.

Laudon, K., & Traver, C. (2001). *Business. Technology. Society*. Boston, New York, NY: Addison-Wesley Longman Publishing Co., Inc.

Michelleti, M. (2003). *Individuals, consumerism and collective actions*. New York, NY: Palgrave Macmillan.

Moon, Y. B., Oh, S. W., Kang, H. J., Lee, H. S., Kim, S. J., & Bang, H. C. (2013, September) Smart Mirror Health Management Services based on IoT Platform. In *Proceedings of the 14th International Conference on Applications of Computer Engineering*, (pp. 87-89). Seoul, South Korea.

Randelli, G., Bonanni, T. M., Iocchi, L., & Nardi, D. (2013). Knowledge acquisition through human–robot multimodal interaction. *Intelligent Service Robotics*, *6*(1), 19-31.

Solima, L., Della Peruta, M. R., & Maggioni, V. (2016). Managing adaptive orientation systems for museum visitors from an IoT perspective. *Business Process Management Journal*, *22*(2), 285-304.