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Towards a Next Generation Universally Accessible 'Online Shopping-for-Apparel' System

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Abstract. This paper reports initial research findings from on-going longitudinal participatory design studies within a national (Danish) funded project to realize a gesture-controlled 'Online shopping-for-apparel' system – A Virtual Dressing Room (VDR). A product that reduces customer purchase returns, reportedly up to 40%, which is a huge burden to the clothing industries as shopping percentile of sales online continues to increase, is targeted. Three studies are reported where results cumulate to highlight the need for continued research to realize a next-generation system to improve the user experience of online shopping for apparel where conclusions point to the need for adaptive user interface improvements. Unforeseen was that wheelchair-bound public especially responded positively to the potentials for the concept due to their limited mobility in shopping and this accessibility aspect can be a significant future market.

Keywords: Online shopping system, purchase returns, e-shopping experiences.

1 Introduction

The United Kingdom Office of National Statistics reveals that the average weekly value for Internet retail sales in June 2012 was estimated to be £493.3 million[1]. It is predicted that by 2018, 35% of clothing sales will be via the Internet[2]. However, current figures show that between 15-40% of apparel purchased online (e-shopping) is returned because customers deem they do not fit[3] or do not look right[4]. Trust policies that safeguard customer purchases enabling such returns are influential and, in some cases, these policies are reported as being abused whereby a purchase is received, worn, and then returned with full credit or refund. In the clothing industry, such high volume of returned apparel is economically disastrous and it is in respect of this

[1] http://www.ons.gov.uk/ons/rel/rsi/retail-sales/june-2012/stb-june-2012.html

[2] Heikki Haldre, a founder of Fits.me, an online fitting room service that creates custom virtual mannequins for people to dress with clothes before buying them.

[3] http://online.wsj.com/article/SB10001424052702304724404577293593210807790.html

[4] http://www.imrg.org

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problem that the project is directed. Thus, the main goal of this work is to realize an online shopping-for-apparel system in the form of a Virtual Dressing Room (VDR) where contemporary camera-based ICT is used to reduce consumer returns.

In order to develop a turnkey solution, a participatory design (PD) approach has been applied in line with Brandt [1]. Fundamentally PD represents a set of theories, practices and studies whereby user communities play a substantive role in activities that can lead to the creation of software and hardware computer technologies and their application in real-world contexts [2-4]. The benefits of adopting such an approach for the design of the VDR system include a better understanding of the reasoning behind online purchasing behavior. This is important particularly given that these numbers are expected to rise even more in the future with predictions of online sales in Western Europe to increase at a 10% compound annual growth rate over the next 5 years[5]. Findings from the PD field studies are periodically fed into the technical partners process pipeline to support development decisions. This paper presents the result from the two initial phases of the design process, namely the preparation and the incubation phases (c.f. Seifert et al. [5]), which represent the initial inspirational and definition phases where the problem was defined and potential solutions identified.

2 Related Work

In the clothing industry many fit technologies have been tried and flopped. For example, retailers have created virtual mannequins for customers to dress and set up full-body scans in stores. It was found that shoppers are reluctant to use systems that require much effort and time unless a special purchase is the goal. It is acknowledged that for women's clothing in particular, sizing is difficult for many complex issues including the psychological. One brand's size 12 is another's 10 or 14, primarily because fashion labels shape their clothes so differently, using their own closely guarded specifications to create patterns. Online retailers often ask shoppers to consult "fit charts" or type in body measurements, which can be time-consuming. However, the True Fit system reports increased sales and reduced returns up to 30% (premier denims). Consumers create a profile of age, height, weight and body shape. Then the customers select items that fit well from their own closets and identify the brands, styles and sizes to True Fit. Another personalized online shopping approach by Stitch Fix[6] involves female customers filling out a similar profile form whereafter online photos of clothing and accessories are rated to give the company an idea of the client's taste. NoMoJeans[7] takes precise customer measurements with a 3D body scanner which are kept on a data base for future purchases.

This paper reports initial trendspotting (field) and participatory design (PD) studies, conducted to unfold tendencies, key patterns and personas related to on- and offline shopping. The trendspotting included structured interviews with different user

[5] http://www.forrester.com
[6] https://www.stitchfix.com
[7] http://www.nomojeans.com

segments representing consumers and retailers/industry. The consumer segment were women 18-30 years of age (n=15). Furthermore, observations of consumer shopping behavior was conducted in combinations with focus group interviews with females 18-35 years of age (n=7), expert interviews (sales staff) (n=3), and document analysis (magazines, shopping forums, statistics, industry reports).

A field study was conducted at a public trade fair in Copenhagen, which included video observations, questionnaires and unstructured interviews (n=11) where the freely available LazyLazy[8] system was used. Building on these studies a PD study was undertaken at a shopping mall in Denmark's second city Aarhus. This included video observations, questionnaires and a focus group (n=31; females n=20). Following, a low fidelity prototyping approach was used in order to get useful design feedback from students attending Aalborg University Esbjerg, Denmark.

3 Retailer/Industry Trend Spotting/State-of-the-Art Study

Five selected companies were visited to determine state of the art in the industries associated with apparel shopping in order to supplement the PD research. These were:

1. ***Inition*** - http://inition.co.uk - a preliminary prototype was presented based on a single Kinect live mirroring the customer (similar to LazyLazy). The system was demonstrated in combination with interviewing of the system creator and VP sales. Clothes are selected from an image menu and a superimposed overlay positioned onto the live video feed, thus, in this system there is no need to disrobe.
2. ***Shape Analysis*** - http://shapeanalysis.com - a proprietary multi-camera system (4) marketed in partnership with [TC]2 in USA. The customer needs to disrobe for precision scanning. Their latest systems offer a choice between a single Kinect (2D) or four Kinect system (3D – 360 degrees). The software generates an avatar (wireframe but can superimpose own face or selected clothing) giving precise measurements. The system was demonstrated by creating the researcher's body scan. Furthermore, interviews with the creator and marketing person were conducted.
3. ***Bodymetrics*** - http://www.bodymetrics.com - a proprietary multi-camera (4) system with installations in leading stores in London (Selfridges – where tested/interviewed staff and clients) and USA (Bloomingdales). The latest system uses single or multiple Kinect cameras for boutiques and home uses. The software generates an avatar that mirrors customer rotation in real-time. The interviewer viewed the system together with the CEO/creator's representative and VP sales. Furthermore, staff (2) and customers (2) were interviewed. Customers complained of a need to initilly disrobe for scanning, then having to dress to get clothing from staff in the public area, and then to go to a fitting room to disrobe again to test apparel feel and fit. This process is being changed using a female only area.
4. ***Holition*** - http://www.holition.com – as (1)

[8] http://www.lazylazy.com

5. ***Cristina Holm, Personal Image Stylist*** - http://www.cristinaholm.com - a four-camera scanner setup with software generating an avatar (static generated for precise measures – as 2). The [TC]2[9] NX16 scanner is located in a private studio where made-to-measure exclusive clothing is designed and sold. [TC]2 company launched a more affordable Kinect-based solution in February 2012[10]. The system was demonstrated with resultant scan obtained. The owner/stylist, was interviewed alongside the system inventor. The 3D avatar can be rotated by a mouse and personalized with an image of the client's face.

The protype by Holiton/Inition was without accurate measures and used flat screen monitors in landscape mode. All of the companies are developing a single Kinect for home use and multiple systems targeting boutiques, custom tailors/designers, etc.

3.1 Customer Trend Spotting Study

The customer trend spotting study resulted in a shopping behavior analysis and personas in terms of fictional characters. The shopping behavior analysis identified the following main trends:

- *Fusion between online and offline shopping*. The customers would like to see big screens in the stores where it is possible to link to the online webshop.
- *Service level*. Some of the customers considered online shopping convenient and stressed that offline service should be improved to give value to offline shopping.
- *Convenience*. The customers preferred online shopping due to that it is not bound to time and space so they will, thereby, save time; they do not need any transportation; and they do not need to wait in any line.
- *Feel, touch and realism*. The customers stressed that the feeling of the clothes, the touch, and the realistic trying-on experience are desired features that enhance the shopping.
- *Online tools enhancing offline shopping experiences*. The customers suggested that online tools, such as size and fit information, texture detail, matching of clothes to the individual's specific body type would enhance the offline shopping experience. Furthermore, social media, such as FaceBook, where the customer can share photos of the potential purchase and receive immediate feedback, would also enhance the offine shopping.

Furthermore, the customer trendspotting study showed that personal issues such as sizes in not purely a technical question for virtual dressing room solutions, it constitutes a highly emotional issue. Some of the customer suggested that this issue should be handled with humor, for example the body could be replaced with sketchy models or 3D avatars attached with humor-directed comments, e.g. "yes, you fit into this model, but you cannot breath....".

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[9] `http://www.tc2.com`

[10] `http://www.tc2.com/newsletter/2011/113011.html`

Four personas, fictional characters, emerged from the customer trendspotting study:

- *The practical non-shopper*, represented by Anna, a teacher, 29 years of age. She works roughly 37 hours per week. Buys clothes one (1) to two times per year, mostly in stores. She always checks the quality in a store before ordering clothes online. She buys for practical reasons, mainly out of necessity. She can go shopping by herself but also with friends to have a good day out. *I like to try on the clothes and I like the social experience with my friends. I would definitely also buy clothes online if I could afford it. Since I cannot afford it very often, I choose to make special occasions out of the real shopping experience*.
- *The lone shopper*, represented by Jacob, university student, 23 years of age. Jacob works as a weekend waiter and buys clothes in stores and online. He usually goes for offers and mainly shops alone as he finds it a bit boring. *I mostly need functional clothing and in the end it is me who should feel comfortable wearing the clothes. Others should not decide what clothes I should wear.*
- *The social shopper*, represented by Tina, senior college student, 20 years of age. Tina works one or two days per month in a bookstore. She lives with her parents and prefers to buy clothes in stores and often with her friends. She uses 1000 DKK per month on clothes (on average). She looks for the brands and good offers when shopping. Tina shops on average 12-20 times per year and often this is combined with a day with her friends. *It is just one of those things that is more fun to do together with friends combined with café-visits.*
- The *spoiling-mom shopper*, represented by Linda, physiotherapist running own clinic, 44 years of age. Linda works roughly 37 hours per week having two children. She most often buys clothes for others than for herself. When she buys clothes for herself, it is moslty for practical reasons. Linda enjoys buying clothes in offline shops, but occasionally buys online. When buying for others, she is very aware of fashion and trends. *When I buy clothes for others, I do so because I see a style in the stores which I think would fit the person, then the price doesn't matter that much*.

3.2 Field Study

Shortly after the trendspotting study focusing on industry and costomers (i.e. sections 3.1 and 3.2) an initial field study with public interviewees was conducted at a major Scandinavian Trade Fair event that attracted more than 7000 attendees[11] to the *Health & Rehab Scandinavia* at the Bella Center, Copenhagen 22-24 May 2012.

Questioning of attendee trends in shopping (online/offline) was conducted from a large stand where videos of current state-of-the-art systems and simulations were used to question public opinions of online shopping for apparel systems (figure 1). Wheelchair bound interviewees made clear their need for improved means to purchase clothes without having to leave their homes. The perceived ease of use (PEOU) and perceived usefulness (PU) toward enhancement and reduced effort of an online

[11] `http://www.liftup.dk/index.php?id=130,247,0,0,1,0`

apparel purchasing system were seen as key factors for wheelchair-bound consumers. However, it is clear that the UI needs to be adaptive to overcome challenges such as illustrated in figures 2 and 3 that highlight interface/setup design considerations.

Fig. 1. Different state-of-the-art virtual dressing room solutions questioned

Fig. 2. Current UI problems (left; height/handedness) (right; distance view/operation)

Figure 2 (left) illustrates a participant who was in a wheelchair, which placed him lower in the picture than other participants. As a result, he could not reach the button at the top. He used solely his right hand to make selections, which provided difficulties when trying to reach the buttons on the left side of the screen. Younger children had similar issues with reaching as they were also positioned lower in the picture (due to their height). The figure 2 right image illustrates a participant who was standing too far away from the camera, which was necessary in an attempt to see her lower body and the selected to preview trousers. As a result, she had trouble reaching the buttons at the sides of the screen and the image was too small because of the distance. Figure 3 (left) illustrates how the participant had difficulties interacting with the system because the buttons were activated by motion (of other people) in the background. The right image (figure 3) illustrates persistent single-handed interaction and body twist to operate, even though participants complained it uncomfortable.

Fig. 3. Current UI problems (left; background triggering) (right; single handedness)

3.3 Participatory Design Studies

Following on from the above-mentioned investigations, two teams of university students conducted participatory design studies at a leading shopping mall in Aarhus, Denmark's second city. An online retail boutique system called LazyLazy was demonstrated to offer research observations of an online apparel system use. The data from this study led to UI investigation via focus groups of a created test image of possible improvements to the commercial product's user interface.

LazyLazy is an online shopping mall where customers can purchase via the Internet (screen capture examples figures 2 & 3). The observed demonstration set up for the studies included a flatscreen TV with a camera used by the software, and two cameras for ethnographic analysis, i.e. the prototype sessions, video observations,

Fig. 4. The general set up of the user study at Bruun's Galleri, October 2012

questionnaires, and unstructured interviews (figure 4). The results were used to generate an improved User Interface (UI) being proposed (figure 5) that was tested by focus groups of independent university students.

The results indicated that some of the users asked why it was impossible to move the clothes left and right when they could move them vertically. They requested the option to select other clothes directly from the system, without having to return to the main page (which in the LazyLazy system requires going back to the computer and using the mouse. The system should be able to remember the size of an adjusted piece of clothing, as well as recognize the size of the user in general. Furthermore, the users would like to be able to view accessories (e.g. watches, hats, glasses) together with the clothes. The UI should allso offer the possibility to view the back of a piece of apparal (especially since some have patterns or pictures on the back). Some users also asked for the possibility of using voice control to interact with the system.

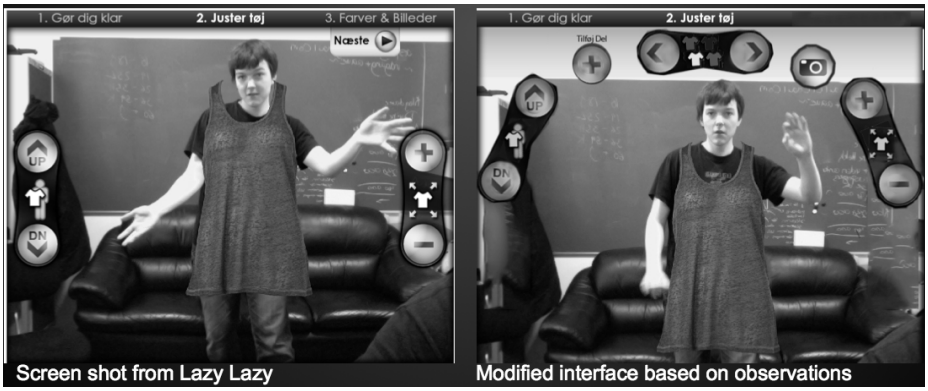

Fig. 5. Existing interface (left) and proposed interface (right) as tested by focus groups

Figure 5 shows a proposed change to the LazyLazy UI with button relocation and two steps combined into one. Three focus group interviews were conducted with 13 participants, approximately 30 minutes per group. Feedback was that the existing interface was considered as less overwhelming for new users; incrementaly takes the users through step-by-step; and is very guiding. The proposed interface was considered as allowing modifications of all aspects in one step; buttons were easier to reach; and looked nicer. Both were judged to need improved and larger text. The preferred design was 3/10 in favor of the proposed change of UI design.

4 Conclusions

Online shopping means not having to deal with crowds or pushy/inattentive sales personnel. It also saves money on travel expenses (car, petrol, parking…) and ease of getting the goods through your door via direct postage/freight delivery that means no 'mountain mule' shopping (or public transport) with numerous bags encumbering the person. Thus, potentials for an optimal system are huge, however, many constraints

limit such optimization, mostly feel and fit aspects. The goal of this project is to advance the state of the art via an optimal dynamic system that would reduce purchased apparel returns.

Design options in such work include for the user to control a matched avatar through body gesture. However, this has not been implemented in the VDR project where the focus is on a mirrored representation with a superimposed overlay using camera recognition and mapping.

A challenge, known and strengthened according to the PD studies to date, is the feel and fit aspects. In line with this are the technical challenges involved in cloth dynamics (mirrored) simulation where the virtual matches the physical such that interactive rate correspondences between the 2D and 3D views and the simulation addresses geometric nonlinearity and frictional contact while remaining stable even under rapid user input. The Sensitive Couture tool [6] claims to address such issues by combining techniques including (i) fast prediction of 3D forms from cached shapes using sensitivity analysis and generalized moving least squares, (ii) fast invisible re-meshing using positive mean value coordinates to accommodate arbitrary revisions of the pattern boundary, and (iii) stable and accurate cloth modeling using an isometric bending model, a modified St. Venant- Kirchhoff membrane element, and progressive refinement.

PD outcomes also point to size of monitoring screen being problematic with a need to balance distance to view full body comfortably and ease of interaction with UI buttons. To help eliminate issues such as illustrated in figures 2 & 3, future research is posited to explore using large screen portrait orientation (vs traditional landscape orientation) monitors that enable real-time 3D auto stereoscopy[12].

Wheelchair bound interviewees made clear their need for improved means to purchase clothes without having to leave their homes. The perceived ease of use (PEOU) and perceived usefulness (PU) toward enhancement and reduced effort of an accessible online apparel purchasing system were key factors when wheelchair-bound consumers were questioned. This highlighted how a market opportunity is clearly evident for people in wheelchairs to augment accessibility when purchasing for self or partners, family, or friends.

Conflicts of Interest Statement. The authors have no conflict of interest to disclose.

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