Mobile Product Customization

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Abstract
Many companies are using the web to enable customers to individually customize their products that range from automobiles and bicycles to CDs, cosmetics and shirts. In this paper we present a mobile application for product customization and production within a *smart* factory. This allows the ad hoc configuration of products at the point of sale (POS). We investigate human factors when customizing products while interacting with them. We focus on the concept of the mobile client that enables this ad hoc modification, but also present the production chain behind our product. We believe that this particular 3D interaction with a product and a mobile device help to improve the customer satisfaction as it allows for customizing a product in an easy and intuitive way. From a CHI perspective an important aspect is that our mobile augmented reality interface can help to match the costumer's expectations with the final modified product and allows the most natural and intuitive interaction. As a use case of the system, we present the modification of a soap dispenser.

Keywords
Mobile interaction, product customization

ACM Classification Keywords
H.5.1 Multimedia Information Systems

General Terms

Human Factors

Introduction

In today's retail environment the stores more and more try to meet the expectations of the consumers. They not only strive towards an unmanageable range of products to supply the consumer with the desired product, they also giving them more and more the opportunity to customize the product. In the last ten years a change from mass manufacturing to mass customization of products has taken place [6]. Lately many companies went one step further and enabled the customers to personalize their products online and then manufacture it for them. For example websites exist where costumers can customize standard sport shoes in terms of color and texture for an additional fee. This shows that a huge market for such services exists and that customers are willing to pay an extra fee for the customization of their products. The drawback of all these web-based services is that the client only gets a virtual version of the product. Indeed most of the services allow a 360° view of the final product but this is in most cases neither easy nor natural. Besides this shortcoming, the products are not directly available, the purchaser has to wait until it gets assembled and delivered. In this paper we investigate human factors when allowing costumers to customize the products directly at the POS. In doing so we believe that the adjustments to the products become a tangible experience, like deciding which product should be taken out of the shelf and put into the shopping cart. Our mobile prototype enables the user to get direct feedback about the look and feel of customized products. By utilizing an augmented reality overlay over the commodity users can manipulate the product specification and interact with a real product at the same time. In addition we highlight how this product can be produced on the fly.

So-called Smart Homes have been established all around the world, these instrumented environments test the interaction of new technology in the field of consumer products. For industrial applications today only few of such smart instrumented factories exist, e.g. the *SmartFactoryKL* of the DFKI (German Research Center for AI) in Kaiserslautern, Germany [9]. These automated factories allow altering the production chain on the fly and thus making products with changed properties available on demand. Combined with a mobile device, which let the user customize a product, such a factory could produce for the user matching products right at the POS. The prototype presented in this paper is able to communicate the specification of the customer designed product directly to the *SmartFactoryKL* and therefore makes the products available immediately and creates a seamless shopping and customization experience.

Related Work

Web-based clients for product customization are widely spread: As already mentioned in the introduction shoes manufactures such as Nike, Rebook, Adidas and others allow web-based customization. The services NIKEiD[1] and miAdidas[2] are the most prominent examples. Reebok developed with *Your Reebok*[3] an iPhone application that allows the user to customize a shoe

[1] http://nikeid.nike.com

[2] http://www.adidas.com/en/miadidas

[3] http://www.mobilemarketer.com/cms/news/commerce/3247.html

just to his needs and expectations on a mobile device. This makes it possible to examine the original model of the shoe in a store while designing a personal version of it on the mobile device. Of course other products of the product catalog of these companies are customizable (e.g. clothing, shirts) [8]. Of course there is a huge variety of customizable products ranging from desktop computer, laptops, bicycles, postcards, toys, cereals, coffee, cars, to jewelry and cosmetics [6]. Customization in that sense means that the costumers is able to select a combination of properties that lead to a new design variation. Not only with the release of the FLARToolkit (Flash toolkit to allow web-based Augmented Reality (AR) applications) many augmented reality advertisements appeared there are stand alone applications as well trying to make products such as customized sun glasses more tangible. But of course users prefer wearing real sun glasses, in comparison, to wear an augmented reality sun glass. With the Virtual Mirror Bichelmeier et al. [4] presented an augmented reality approach for visualization of customer adapted shoes. As an extension of the miAdidas [4] web application, the system records a video stream of the user wearing the standard model and overlays it with the customized design of the user. One disadvantage of this system, besides the fact that the customization process is done online and that the user can only examine the final design, is that it needs an instrumented mirror available at the store. In contrast to related work we use a *mobile magic lens* [1] approach, which allows customizing a product (see figure 1 and 2). Our application combines the customization process with the augmented reality aspect by integrating a physical product instance directly into the virtual modification process. Interaction concepts for tool glasses or magic lenses with different kind of objects are well studied [7]. In our approach we provide a video see-through interface on the product with a camera-equipped handheld device. The user's view is mediated by the device and combined with different graphical overlay on the display of the device. The user acts on two layers of information the "transparent" device screen in the focus and the product, in our case a soap dispenser, in the visual context. The camera display unit acts as a movable window into a computer augmented view of the product.

Interaction Concept

In our System, the customers can use their cell phones to customize the desired products on the fly at the point of sale. As a use case of the system, we chose the customization of liquid soap, because different properties of a soap/ soap dispenser can be modified easily and quickly, e.g. the color, fragrance, ph-value and other ingredients. In addition the soap/ soap dispenser can be easily produced within our living lab called *SmartFactoryKL*. The basic *SmartFactoryKL* production infrastructure consists of a continuous production process, in which raw soap is processed and colored, and a subsequent, discrete production process, in which the colored soap is bottled, sealed, labeled and commissioned. The complete process is designed strictly modular according to the principle of "plug'n'work", which means that each module in the process chain consists of an independent mechanical structure and control unit with a clearly defined function [5]. This can support the integration of parts of the factory into grocery or drug stores. To customize the product, there are two possible ways of interaction.

Figure 1: A user is customizing the color of a liquid soap. The soap dispenser is held in front of the mobile device camera (left). The user can pick a color (middle) and a preview image is displayed. The product than can be ordered with a single click (interaction schema 1).

Interaction Schema I

The underlying idea is to enable easy and arbitrary customization of production processes and to support producers in coping with highly customized products. When producing soap, there are several properties, which are highly customizable. These properties can be visual, like the color of the soap, but they can also be non-visual like the fragrance, pH-value or concentration of the soap. The users can *scan* a product with their mobile phones to determine which properties of the product are customizable at all and what the current values of these properties are. *Scanning* means that the mobile device is used like a *magic lens* to determine several properties of the product. To determine visual properties like the color of the product, the users can put a real product in the sight of the mobile phone's camera. The system automatically analyzes the camera image and determines the visual properties. The system detects the color of the product on the image and the customer can customize the color based on the detected value. He gets the feedback on his mobile devices, seeing the soap with a virtual color in the video stream. This can also be seen in figure 1. When the user is satisfied with it, he can order the right soap directly from the *SmartFactoryKL*. The limiting time factor is the transportation way from the factory into the store. The soap can be produced in minutes. While the *SmartFactoryKL* is highly modular, one can think of integrating several modules directly into the stores (e.g. the coloring part).

Interaction Schema 2

In the second interaction schema, the product is not adapted the costumers needs, but to the costumers environment. The costumer takes for example a photo of her bathroom. The system then detects the average colors appearing in the bathroom and deriving a color palette. The system now suggests a color for the soap to the customer and she can pick the right color fitting to the colors of her bathroom. This is illustrated in figure 2. Both ways of interaction have in common that after the customer finishes the customization of the product, he can see how the customized product looks on the mobile phone. The mobile phone sends the customization data directly to the *SmartFactoryKL* to integrate the product customization directly into the production chain. By the use of this concept, the customers can interact with a real product to customize it. They get direct visual feedback on their mobile phone. By the integration of the customization process

Figure 2: A user is taking a picture of a bathroom and the system than suggesting an adequate color matching the design of the bathroom (interaction schema 2).

into the product chain, the customers also immediately see how the customized product is produced and how it looks in real. When the user is done with customizing the product on the mobile device, the device sends the customization data directly to the *SmartFactoryKL* to integrate the product customization directly into the production chain. The user can immediately watch the factory producing the customized product.

Implementation

To test our system, we implemented a prototype for Apple's iPhone platform. With the prototype, the user can either scan a real product by taking a picture of it an use the products color as basis for the color customization or he can take a picture of his bathroom a customize and request a color that matches the colors in the bathroom. In order to change the color of the soap virtually on the image, the contours of the soap bottle are detected. Therefore, the image is transferred into a grey scale image in the first step. In the next step, the active contour model of Chan and Vese [3] is applied to obtain the contours of the bottle to adapt the perform the replacement. Other approaches (e.g. having a visual barcode on the dispenser in combination with a 3D model of it) are also feasible. To determine the colors appearing in the image of the bathroom, we observe the normalized color histogram of the image. Color histograms are invariant to translation, rotation around the viewing axis and change slowly with distance to the object and partial occlusion. The proposals for matching colors are calculated on the basis of the color histogram.

The spectrum of colors that can be mixed by the *SmartFactoryKL* within the process is nearly unlimited. Similarly to an ink-jet printer, the subtractive color model is used to reproduce the desired color out of the three basic colors cyan, magenta and yellow. However, the flexible production structure provides basically way more parameters to configure, such as type of the bottle, filling quantity or pH-value of the soap. The current job management in the *SmartFactoryKL* functions as follows: Once the individual product was designed, the order is sent to a server-based production planning and control tool (PPC). Since the production system consists of independent modules, the information, how the product has to be manufactured, will not be processed in a central control unit. In this way the production line is able to produce a large number of product variants in an arbitrary sequence with about 1-2 dispensers a minute (see figure 3).

User Feedback

We collect first preliminary feedback from 6 users in unstructured interviews. We ask them if they want to use such an application. They gave us promising comments such as: “Never have to put a blue soap into my beige bathroom – I just produce me the right one”, or “it would be wonderful to allow customization of the fragrance. Often the best looking soaps are smelling terrible”.

Conclusion and Future Work

With our prototype implementation, we presented an easy to use method for on-the-fly product customization where the user can interact with a real product. We want to make the approach more robust (e.g. color variances caused by different lighting conditions) and allow more customization options. In the prototype, the user can only customize the color of the product as a visual property. As future work, we

Figure 3: The production of personalized soap dispensers in the *SmartFactoryKL*. Color mixing unit (left) and personalized soap dispensers (right).

want to allow the system to determine the non-visual properties of the product. We want to integrate additional technologies like an odor sensor and actuator system into the mobile phone to allow the costumers to change more properties of the product. In addition we want to formal evaluate the advantage of mobile product customization against already web-based services. We think that the close interlocking with the *SmartFactoryKL* is the key to success of those services. The integrated customization and production chain we help to bring these mobile services into the markets. A standalone application cannot be successful in this domain.

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