The design of clothing washable labels based on NFC

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Abstract. In this paper, With the rapid development of NFC (Near Field Communication) technology and the digital advancement of clothing industry, a kind of clothing washable labels based on NFC is proposed and designed in this paper. It can be used to compose a clothing information system together with NFC mobile phones, mobile Internet, enterprise information centers, etc. By experiment, consumers can read and write NFC washable labels through their mobile phones, which can be quicker and more convenient to obtain clothing washing and maintenance information. Moreover, the NFC washable labels conform to the washing requirements of washable labels. The emergence of the NFC washable labels provides a physical basis for smart matching recommendations and precise directional push of clothing advertising information for consumers.

1 Introduction

Ordinary clothing washable labels only contain clothing washing and maintenance information, while NFC washable labels are a contact medium for clothing and consumers, clothing and enterprises, as well as consumers and enterprises.

Along with the digitalization process of clothing industry, Tao et al. [1] proposed a kind of RFID technology scheme for the raw material warehouse management of garment enterprises in 2007, which makes the raw material inventory quantity and inventory structure of garment enterprises more reasonable, improves the informatization of warehouse management, and reduces the cost of production and management of garment enterprises. In 2014, Zheng et al. [2] mentioned that the Central Bank supports NFC payment in the paper titled Promotion Strategies of NFC Mobile Payment Service for Telecommunication Operators, so NFC technology has obtained a relatively favorable opportunity for development and NFC mobile phones have begun to become popular. In addition to the rise of NFC payment, other NFC labels are also gradually used by the public. Ahsan et al. [3] indicated that, among intelligent wearable devices, compared with other short-range wireless communication technologies, NFC technology is more suitable for data communication and information sharing between intelligent wearable users, intelligent wearable devices and other portable electronic devices.

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Based on the above literature analysis and the related research on the digitization of clothing washable labels, existing RFID labels can be well used for clothing fabric storage management, clothing production process, store inventory theft and other aspects. However, consumers cannot build a relationship with garment enterprises through RFID labels due to lack of the means of directly reading RFID labels. In view of this situation, a kind of NFC washable labels is proposed and designed in this paper. Consumers can directly read clothing information parameters and washing instructions on clothing NFC washable labels by their mobile phones, and these labels can also record their clothing consumption habits. Therefore, clothing enterprises can receive and analyze their information so as to carry out accurate information push for them. Moreover, these labels reserve NFC payment interfaces for fast payment.

2 System framework

Evolved from radio frequency identification devices (RFID), NFC (Near Field Communication) technology is mainly used in entrance guard, bus cards, mobile payment, etc. In recent years, Apple, Samsung, MIUI and other mobile phone manufacturers have introduced a variety of NFC-enabled smart phones, which has brought great convenience for the promotion and application of NFC technology.

This system is composed of NFC-enabled mobile phone, NFC washable label, customized APP, enterprise information center, and mobile communication network, as shown in Figure.1. The customized APP is designed and produced according to the requirements of clothing enterprises, and consumers can download it to their NFC-enabled phones through Android or IOS system.
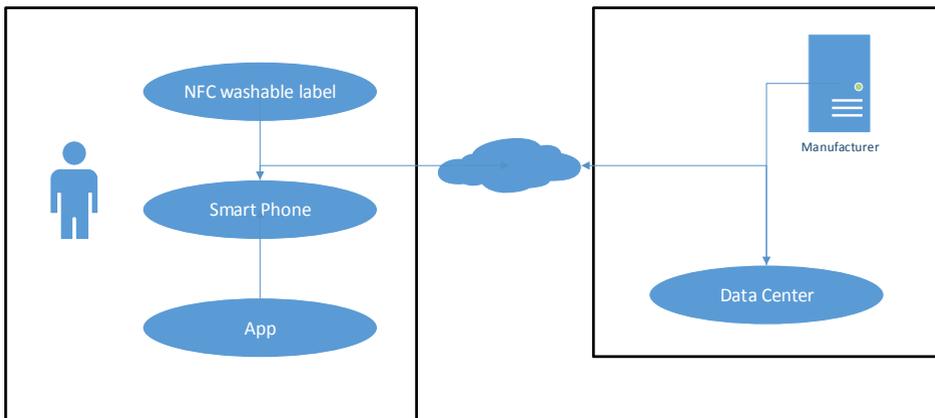

Fig. 1. Clothing information system based on NFC washable labels

The working procedures of the whole system are:

1. Starting with fabric tailoring, a globally unique identifier will be compiled on the basis of each NFC label, thus the entire garment production can be tracked;

2. When clothes are completed and turned into the inventory for management, they will be delivered to the stores in different quantities, or be directly sold online according to the actual situation of production and sales;

3. As soon as consumers buy the clothes and read NFC washable labels with NFC mobile phones, the consumption location, consumption time, and the information of purchased clothes will be recorded;

4. After purchasing the clothes, during their daily use, open the APP before wearing them every time, and then put it close to NFC washable labels to record the frequency of wearing. The clothing maintenance information will be pushed in the evening;

5. Consumers' information is recorded and uploaded to enterprise information centers through the APP. According to each user's feedback, combined with popular trends and the analysis of large data, users' dress collocation recommendation and advertising information push are conducted through a specific recommendation algorithm.

3 Introduction of NFC labels and their partition

The type of NFC washable labels is NLABEL216 developed by NXP Semiconductors with non-contact data transmission and power supply; its operating frequency is 13.56 MHz, data transmission 106 kb/s. Its data integrity includes 16-bit CRC, odd-even check, bit coding and bit count; its maximum working distance is 100 mm (depending on different parameters such as field strength and physical dimension of antenna). The size of the EEPROM is 924 bytes, organized with 231 pages, 4 bytes per page, in which there are 888 bytes for users to freely read / write in the area (222 pages); the first 16 pages have a field-programmable read-only lock function in every page; after the first 16 pages, there's the field-programmable read-only lock function at every 16 pages. The configurable password protection has an optional failure attempt limit function; the anti-modification function supports the functional containers (CC) and lock bits; the original inspection supports ECC. The data retention period is 10 years; the tolerance of write operation is 100,000 cycles.

The details of partition are shown in Figure 2:

Fig. 2. NLABEL216 basic partition map

User Memory occupies a total of 888 bytes, which is a developable and designable part of NFC labels, and is divided into read-only information and changeable information for users. The read-only information provided by clothing enterprises includes: product name, reference price, model, clothing style, product composition, company profile, introduction of the brand culture, washing instructions, product production tracking, etc. The specific requirements can be set according to different enterprise requirements. The changeable information for users includes: evaluation of the clothes, self-designed collocation and choice, etc.

4 Design of digital washable labels based on NFC

There are mainly two different designing schemes — packaged type and post-paste type. From the aspect of used materials, the former gives priority to non-woven fabrics, the later polyester. From the appearance, NFC washable labels are nearly the same as ordinary washable labels in size, material, color, design and other aspects, with the width of 2-3 cm and the length of 4-8 cm in general; the difference comes in the combination mode between the NFC labels and the washable labels, and different combination has a small impact on the physical properties of the washable labels, and the design can still be conducted in accordance with that of the ordinary washable labels, only in which the combination of the NFC labels and the washable labels is added. Merchants choose the matching washable label according to different types of clothing; for example, clothes for autumn and winter are relatively thick, and the packaged type is generally a better choice; clothes for spring and autumn is relatively light and thin, and the post-paste type is a better choice.

The packaged-type NFC label adopts the Wet inlay technology to form an integral part with a width of 18 mm and a length of 43 mm, as shown in Side A and B of Figure 3. The identification of washable label printed in the frontage such as style number, color, size, washing instructions and others, has the width of 30 mm, length 75 mm, as shown in Side C and D of the Figure. Side B and D are combined by waterproof glue, then goes to the combination state of a washable label and a NFC label shown in Side E. Side E and C are combined again by waterproof glue to form a whole body.

The design of NFC label in post-paste type also adopts Wet inlay technology to form an integral part with a width of 15mm and a length of 35mm, as shown in Side A and B of Figure 3. The material of washable labels is polyester fiber; the dotted line in the middle is the crease. Side D is the frontage of the washable label, on which washing instructions are printed as ordinary labels do with the width of 25mm and the length of 100mm (50mm after folded according to the dotted line); NFC label is directly bonded with reverse side of the washable label; the result is shown in Side E.

5 Waterproof design for washable labels

According to the waterproof requirements on the electronic products of IEC 529-598, GB 4208-2008 and other standards [4], NFC washable labels need to match the IPX7 waterproof grade requirements: if the electrical equipment is immersed in water for a certain time or water pressure below a certain standard, it is ensured that they cannot be damaged due to immersion.

In order to make the designed and produced NFC washable labels achieve the required waterproofness, the Wet Inlay technology is adopted in the production of NFC labels, as shown in Figure 3. Firstly, two pieces of aluminum foil and PVC material are hot-pressed and composited to form antenna; after point DELO glue onto the solely-produced chip, it is aligned to the antenna bonding pad. The chip is fixed to the antenna bonding pad by hot pressing; the glue is solidified at the high temperature of over 200 ℃, so the complete Dry Inlay is formed, that is, the medium material of the NFC label is formed. Both sides of the medium material are coated with glue; with a waterproof, wear-resistant surface base material and the backing paper, the glue is solidified by hot pressing finally. So the formed Wet Inlay NFC label has waterproof and wear-resistant characteristics.
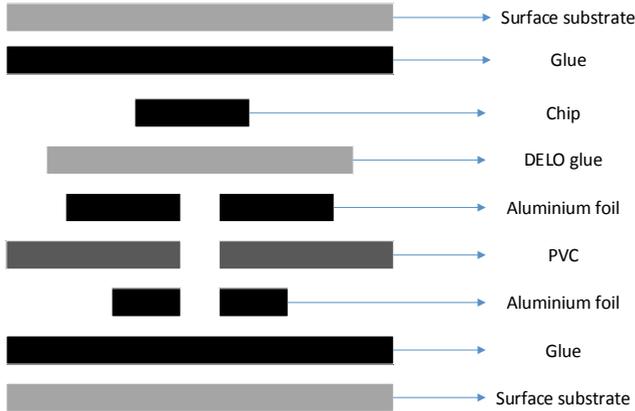
Fig. 3. Wet Inlay technology

6 Experimental results and analysis

In order to detect the waterproofness of NFC washable labels and the number of NFC washable labels used in actual, the IPX7 experiment on NFC washable labels was carried out. The standard experimental requirements of IPX7 are: Under the standard atmospheric pressure, the sample is placed into the immersion tank. The distance from the bottom of the sample to the water surface is at least 1 m. The distance from top of the sample to the water surface is at least 0.15 m. With the time duration of 30 minutes, the sample can still work properly.

According to the actual situation, some changes are made to the IPX7 experiment: Under the standard atmospheric pressure, 10 copies of the same NFC washable labels with numbering 1-10 were sewed in the same piece of cloth, then being placed into the ordinary washing machine for immersion; and neutral detergent was added. After they were washed for 30 minutes and dried at low temperature, the information on the washable label was read with a NFC mobile phone, and the printed surface was observed.

The process of NFC mobile phone reading and writing NFC washable labels is: compiling the APP that can read NFC labels by HBuilder, then packaging and installing it in the NFC phone; opening the APP, the distance between mobile phone and NFC sewed-in labels shall be less than 10 cm. If the phone can quickly read the content in the NFC label through the APP, the experimental results shall be recorded as successful, otherwise failed.

The experimental results are as shown in Table 1 and Figure 4.

Table 1. Number of water washing damage

	Label 1	Label 2	Label 3	Label 4	Label 5	Label 6	Label 7	Label 8	Label 9	Label 10	Mean
Number	135	120	156	200	163	200	189	145	200	166	167.4
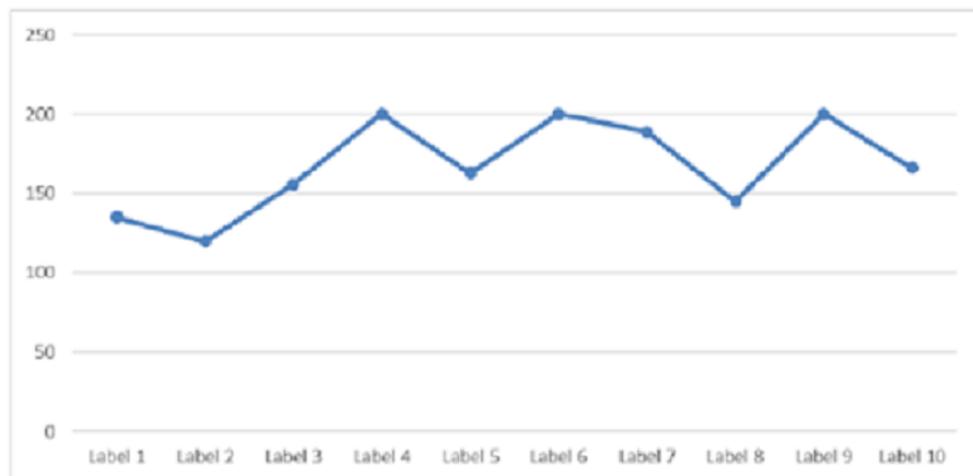
Note: The experiment was carried out for 200 times, those undamaged with the number of more than 200 were marked with 200.

Fig. 4. Number of water washing damage

The results showed that the number of water washing for NFC labels over 150 accounted for 70%, which is in accordance with the consulted number of water washing of RFID sewed-in labels in the market — 150-200, and no significant fading was observed on the surface. All above meet the washing requirements of washable labels.

7 Summary

With the rapid development of NFC mobile phones, the use of NFC labels has begun to affect all aspects of people's lives. The NFC washable labels proposed in this paper give the design of NFC washable labels and the detection of waterproof performance. It provides an interactive way for consumers to easily read clothing feedback information. Consumers can read NFC washable labels to get washing instructions and related information about clothes. Moreover, APP records and consumers' tracks provide a physical basis for intelligent collocation recommendation and accurate directional push of consumer clothing advertising information.

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