Semantic Surfaces for Business Applications

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Abstract. In this paper we introduce the concept of semantic surfaces – surfaces which are enhanced to provide additional information to the one visible, and are able to interact with the user. We consider several approaches to their implementation and in particular show the perspectives of the Cluster Pattern Interface (CLUSPI) technology developed and patented by one of the authors. Various business applications of semantic surfaces are outlined which illustrate the potential of the proposed concept.

Keywords: semantic surfaces, business applications, CLUSPI technology, ubiquitous computing.

1 Introduction

People have been using surfaces for communication since pre-historic times. The early messages were in the form of pictures drawn on rock walls and only later people started using writing systems. Since the technology back then was extremely laborious, the number of messages drawn or carved on stone was very limited. Such messages, however, were meant to last for a long time and cave paintings, created over 35,000 years ago are still preserved today [1].

Later, the technology of writing and drawing evolved significantly and written messages became one of the main forms of communication for an increasing number of people [2]. More and more surfaces of different types such as handwritten letters and paintings, printed books and newspapers, billboards, announcement boards, and others were used for communication. Meanwhile, less durable materials like papyrus, canvas, and paper, as well as new paints, and inks came into use.

Thus, there are three *main trends* in the use of surfaces as information carriers:

1. The literacy level of the population rises.
2. The surface types and quantities increase.
3. The information utility periods shorten.

Nowadays, we live in an environment where an enormous amount of surfaces bring information to us: from books, newspapers, letters, road signs, maps, logos, and labels, to billboards, TVs, computers, and computerized devices, to T-shirts, mugs, key-chains, and even tattoos. Most of these surfaces are static - the message does not change in time, but some, such as TVs and computer screens, change their contents constantly. Most of the surfaces are also not interactive, that is, they do not allow the user to choose any options, and cannot display further details.

The other trend witnessed presently is the immense development of computing and communication techniques, their combination, and pervasive use. In this context, we envisage a world in which there is no boundary between physical reality and the digital one, in which the connection is made through *ubiquitous semantic surfaces*, enhanced with the ability to provide typical services for the digital world and the Internet. This consideration is made in the light of possible applications for various business purposes.

The paper is organized as follows. In Section 2, we give a definition and elaborate on the approach of semantic surfaces. In Section 3, we study various technical implementations of this approach. In Section 4, we consider the patented Cluster Pattern Interface (CLUSPI) technology and its potential for semantic surfaces. In Section 5, we propose different applications, and we conclude in Section 6.

2 Semantic Surfaces' Approach

Definition. We define a *semantic surface* as a type of surface enhanced to provide additional information than the visible one, and be able to interact with the user.

There are various purposes for enhancing the surface with additional information:

1. *The surface area is too small* to encompass all the necessary information to be conveyed to the user. This is the case for some labels on medicines and other products with relatively small packaging.
2. *Customizing the information.* Different information can be shown for different types of users. For example, a piece of text can be shown in English or French, for users who speak either English or French.
3. *Layering the information and dynamic search.* Not all of the information is shown at once, but it is rather organized in a layered form. This is particularly useful when the amount of information is vast: it may be organized in the form of hyper-text.
4. *Enhancement with various types of media.* The embedded information can not only be textual, but it may be a picture, music, voice, video, or a combination of these. For example, an announcement board can be activated to read aloud the text of an advertisement. Analogously, a map may show a short video how to reach point B from point A.
5. *Changing the information.* The additional information can be the same all the time, but it may also be updated when new data arrives. For example, a dynamic newspaper can change its content when it is updated.
6. *Interacting with the surface.* A similar concept to the idea of computer mouse can be applied: the user can point parts of the image and click on buttons, thus activating different functions. This can be used, for example, to visualize various parts of the information or to invoke different media.

Obviously, the above-described concept can be implemented through interaction with a computer. As a consequence of Moore's Law, computers are becoming smaller and cheaper. Today, many appliances and devices – such as microwaves, cell phones, washing machines, and watches – have embedded chips. It is expected that this trend will continue for at least a decade and that computers can practically be embedded anywhere. Thus, they can easily be combined with the semantic surfaces which will serve as two-way information channels.

We distinguish between the following two main types of semantic surfaces according to the *modifications of the visual content*:

1. *Static semantic surfaces*, which do not change their visual content in time. These are the printed documents – books, labels, pictures, packing, and other similar objects.
2. *Dynamic semantic surfaces* can change their visual contents in time. Such are TVs, computer screens, touch screens, smart boards, dynamic billboards, and others.

Note that the additional information in both types of surfaces may change.

Semantic surfaces can also be categorized as *low-interactive* and *highly-interactive* according to their ability to respond to user's actions. Low-interactive surfaces can only supply additional information on activation. Highly-interactive surfaces respond to various actions and can customize their content.

We can also distinguish between *single-media* and *multi-media* surfaces. Single-media surfaces provide additional information of one media type, usually textual, while multi-media surfaces can provide various types of information such as voice, music, and video.

3 Semantic Surface Implementation

In the implementation of semantic surfaces we have to answer three main questions:

1. How to encode links to additional information in a semantic surface?
2. How to locate and decode the links?
3. From where to take the information behind the links?

In addition, we would like to use technology that is popular and easy to implement, so that the user would not need any special training. It should employ mainstream devices to work with semantic surfaces, so that it is not necessary to purchase additional tools.

Below, we explore and comment on several existing technologies that could be used for implementation of the semantic surfaces.

3.1 GPS

Global Positioning System (GPS) is widely used for detecting the outdoor location of objects. Many software applications are based on GPS, as the most popular ones are the navigating systems which work in combination with digital maps. Such digital maps can include direct links to location-based information and services and can therefore act as virtual semantic surfaces. GPS systems, however, need constant access to satellite signals and therefore they are not applicable indoors. They are also not very precise which makes them difficult to use with small physical surfaces.

3.2 RFID tags

An RFID tag consists of a radio antenna and a chip with information that can be linked to the tagged item [3]. This information is transmitted to the reader using radio signals. Different RFID chips can be employed for RIFD tags:

- Active: have a built-in battery for actively sending information through an antenna in their environment;
- Semi-passive: have a battery only for supplying the chip itself;
- Passive: do not have a battery; depend of external power supply.

A benefit of this technology is that reading tag information may be contactless. However, RFIDs pose some restrictions for semantic surfaces use, because they are not suitable for detecting locations on an object, but only the presence of a chip. Other drawbacks are the need of a special reader and the tag power consumption.

3.3 Bokode

There are also some other technologies which can be employed for semantic interaction. For example, a new design created by the MIT Media Lab called Bokode [4] uses a small lenselet and a matrix to record information in a very small area, which can be read by an ordinary out-of-focus camera. The advantage of this method is that the information stored in Bokode can be read from a significant distance and from different angles. However, some disadvantages of this technology are that active lighting by an embedded LED or a polarized flash used by Bokode require additional power source, and that the available information is concentrated only in a few small spots on the surface.

3.4 Printed codes

Printed codes have a great potential and we think that they are most appropriate for semantic service implementation, because they are embedded on the surface itself. Their popularity increased significantly in the recent years – more than 10,000 patent families with 30,000 individual patents were approved for printed codes [5].

Four main groups of printed codes can be distinguished:

1. *Barcodes* are currently the most popular form of printed codes. Most products nowadays have attached barcodes used as their identifiers in the stores.
2. *Individualizing and safety codes* provide a unique code for each individual sheet. They find applications in security print products and in personalized printed products.
3. *Watermarks* are used for the identification of security products without destroying their look.
4. *Printed merge codes* are merged into an image or text so that they are invisible to the human eye, but readable for machines. Experts believe that merged codes will replace conventional barcodes in many applications. We consider them as most appropriate for semantic surfaces.

We illustrate the four types of codes in Fig.1. First, some snapshots of product labels with printed barcodes [6] are shown in the left part (a) of the figure. When one of the product labels is scanned and printed on a trace-enabled color laser printer [7], a distinctive pattern of yellow dots, encoding the printer serial number and a timestamp appear as shown in the second column (b). In the third column (c) we demonstrate how the bar-coded data from the product label can be used for digital watermarking of the label picture [8]. And finally in the right of the figure (d) we show the product label with an overlaid CLUSPI code [9].

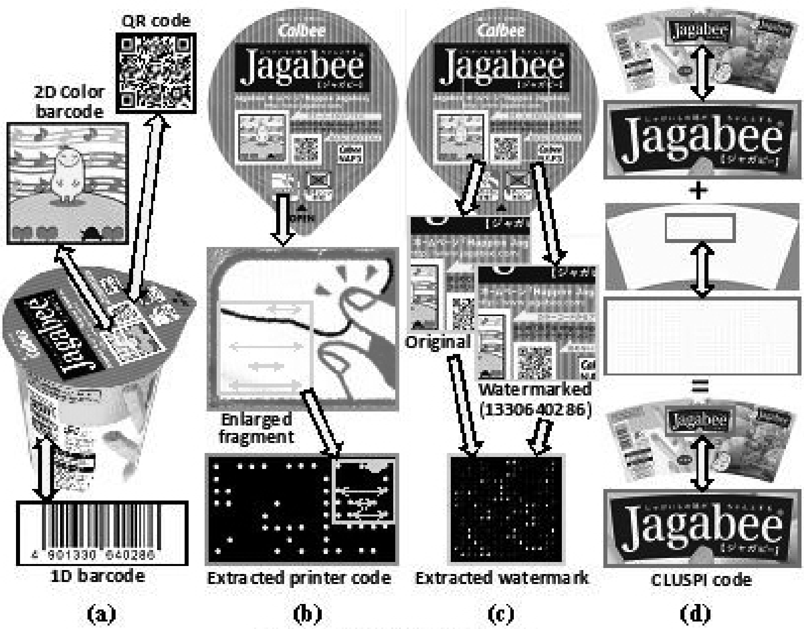

Fig. 1. Various printed codes.

4 CLUSPI Technology

CLUSPI technology was developed and patented by one of the authors of this paper [9, 10]. The idea of CLUSPI is to cover a surface with a non-obstructive layer of code. The code covers less than 1% of the surface area and blends with its content. Thus, it is almost invisible to humans, but it can be easily read by a CMOS camera and recognized by specially developed software. The code defines a coordinate system on the surface and allows locating a position with very high precision – under one millimeter – to be performed by a special pointing device with an embedded camera. Because of the limited space of this work we cannot go into greater detail about the hardware that runs the CLUSPI code so we refer the readers to the cited literature.

Currently, the pointing device, although inexpensive, is not wide-spread, but the same operation in the future can be done through a smart-phone camera. The smart-phone can run the software, locate the pointed position and recognize the required action. It sends this information to a server which keeps a virtual copy of the surface. Some of the locations of the virtual copy are designated as anchors, and through them the server can link to additional information which can be on the same computer or elsewhere. The information is sent back to the smart-phone. Note that it can be not only textual information, but picture, voice, or video as well, since the smart-phone has the ability to process such information. Thus, the technology allows the implementation of multi-media semantic surfaces.

Various actions can be implemented through the buttons of the smart-phone. Another interesting ability of this technology is that it can detect the angle of rotation of the phone with respect to the surface. This can be used for applications which require continuous pointing, for example on a map, and provided as additional functionality. In such a way, through CLUSPI, one can implement highly-interactive surfaces. The above described mechanism, which allows the enhancement of surfaces, is sketched on Fig. 2.

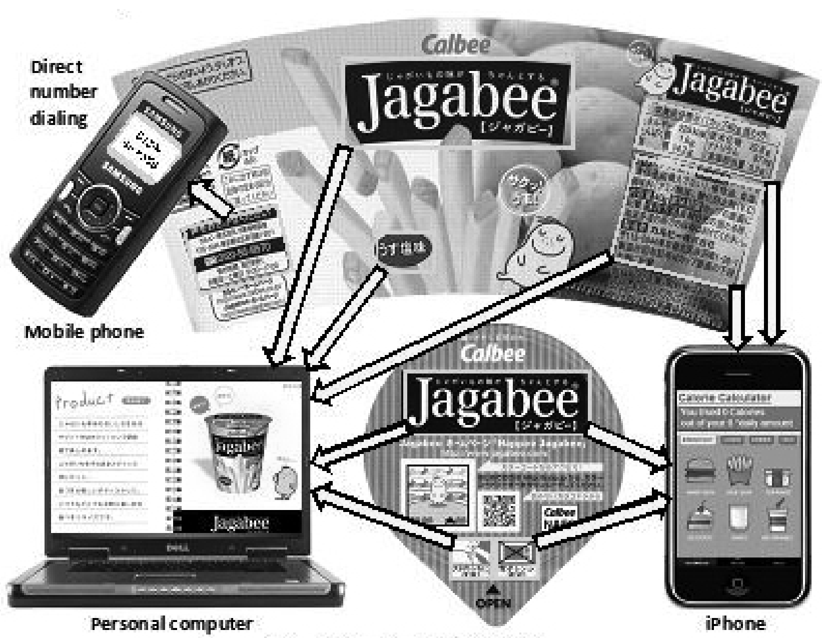

Fig. 2. Work with CLUSPI.

5 Business Applications

There are numerous business applications that can be achieved utilizing semantic surfaces. We will outline some of them below to demonstrate the potential of the proposed concept.

5.1 Newsputers

Newspapers, as we know them today, are expected to disappear in the near future. In fact, in the time of global financial crisis they were the first to run out of business. More and more people prefer their electronic versions, because they provide access to the news instantly throughout the day.

The idea of *newsputers* [11] is to combine the benefits of the printed newspapers and the dynamics of their electronic counterparts through printed codes. In such a way, the users can connect through their smart-phones to the newspaper and follow easily developing stories. The described technology allows articles in the newspapers to be read aloud. The newspapers can become truly international through automatic translation in different languages. The advertisement can also become less aggressive and more focused, because the readers can follow through the printed codes only the ads that interest them. The system can also provide reliable feedback to the advertisers about how many people have actually read their ads. More information about newsputers can be found in [11].

5.2 Presenting multiple views of a product

Another business application of printed codes could be embedding them on brochures or tags too small to hold much printed information, so that additional resources could be quickly accessed through the Internet. For example, a printed code on a wine bottle tag could be made to access the web page of the winery, the type of grape used, the nutritional values, a video about the production process, and driving instructions to the winery. A poster about a concert can be activated to play a piece of the music or to show a short video of the concert. Printed codes can even facilitate the online purchase of a bottle of wine or concert tickets, which can be done through a click on the pointing device.

5.3 Getting feedback from the user

Currently, it is not easy to measure the impact of a given article or advertisement printed in a newspaper. With embedded printed codes, the authors and advertisers can easily get feedback. The users can also easily exchange information among themselves, sending articles and posting comments. They would be able to score certain printed materials or to participate in on-line surveys.

5.4 Enhancing the services

Semantic surfaces can be used in many other ways enhancing the services to people. For example, a map with a printed code can read instructions out loud, and direct a person in an unknown environment where the use of GPS is not possible. A code on a blister of pills can make obsolete the printed instructions for use which are easily separated from the pills and sometimes lost. Thus, the patient can always consult the instructions which can be updated whenever new data is available. In addition, the technology allows easily memorizing in the smart-phone the exact time and date when the pills were taken and reminding the person to take them in time. The above business applications only illustrate the potential of semantic surfaces for business purposes. They can be applied in many other fields. For other possible applications see, for example, [12].

6 Concluding Remarks

With the development of software systems that assist the creation of hybrid emulsions of print and electronic media, printed codes could be embedded on mainstream devices and texts in order to provide further information and resources. This can be achieved on things like newspapers and magazines - to play videos related to news articles, provide further information about a topic, or follow up advertisements. By programming and using smart-phone cameras to recognize the printed codes, we think that such print-based interactive communication could advance existing services and introduce new opportunities for exhausted business models and activities. Future research may be aimed at combining different technologies to create an optimal method of encrypting and decrypting information in semantic surfaces.

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