Color Visual Code: An augmented reality interface for mobile phone[1]

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Introduction

In this paper, we introduce a new marker system, color visual code, to function as an augmented reality (AR) interface for mobile phone. Our goal is to encode as much information as possible into the marker, thus can represent or link to more digital content for augmented reality. This way, the marker can serve as a key to query a database, or as a physical carrier of substantial information, which enables us to use our mobile phone as a new media.

Related work

Our work is partially inspired by Rohs (2004). Their work used a black-and-white visual code to describe an unique ID which is recognizable via a mobile phone camera. They calculated the rotation angle and the amount of tilting of the phone camera related to the code marker as additional input parameters for mobile phone. They used the visual code as a 2D interface for menu-selection and interaction with large-scale display. The capacity of their visual code is 83 bit. In our design, we use a similar frame of visual code and extend it in two ways. Firstly, we increased the information capacity via color bits. Secondly, we further calculated the 3D-3D transformation matrix between the color visual code and the phone camera, and deployed our code as an interface for three-dimensional augmented reality.

Billinghurst and Kato (1999) developed an augmented reality library called ARToolkit. It can be used to develop basic augmented reality functions, including marker designing, marker recognizing and rendering of 3D object using OpenGL. It is the most popular AR library up to now. However, it was not originally designed for mobile phone interaction. The lack of an uniform coding scheme for its marker leads to slow computation for marker recognition and inconvenient process for associating marker and the corresponding digital content. Moreover, it doesn't take full advantage of the marker space to encode more information.

Dell'Acqua et al (2005) designed Colored Visual Tags [3]. It used tricolor (red, green, blue) as its basic colors. Red color was used as the frame of the marker to recognize the region of candidate markers.The marker was divided into square grid with same size, which was then further divided into two triangles. Each triangle has color green or blue. Because each unit can only choose one from two colors, it is essentially a binary marker and doesn't offer a larger information capacity than black and white markers.

Color Visual Code

We design our Color Visual Code (CVC) as a grid of square unit, each unit has its size as small as possible. We also provide a uniform coding scheme to make marker recognition algorithm faster. As shown in Figure 1, CVC is composed of four parts: guide bars, corner stones, benchmark bar and coding area. There are two guide bars with different length. They represent the direction of CVC. Three corner stones represent three vertices of CVC, which are black units. We place the benchmark bar horizontally on the top of CVC. There is one unit distance between the benchmark bar and the left top corner stone. The colors on the benchmark bar represent value 0 to 7 respectively. The wide space in the middle of CVC is used to place the code. For convenience we use small squares for the coding area.

For each input image, our marker recognition algorithm will find the legal code if existing, extract the code and then get the position of the four vertices of CVC. There are following steps: image binarization, connected region detection, CVC locating, computing homography from code

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coordinate to image coordinate and code extraction. Finally, we can obtain a large-capacity coded information and a 3D-3D transformation matrix for augmented reality usage.

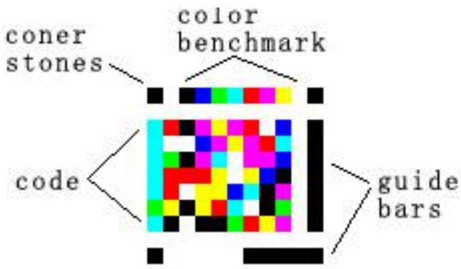

Figure 1. Color Visual Code

Results

We tested our CVC as exactly shown in figure 1. Each marker is a grid of 11 x 11. The coding area is the internal area of 9 x 7 units. Eight colors are used as in the benchmark. Therefore, this CVC's capacity is 9 x 7 x 3 = 189 bits, more than doubled of Rohs (2004) code with the similar code size. The demo is tested on a Nokia 6600 with 300,000 pixels camera.

The result of augmented reality is shown in figure 2. The image on the left is the original view. The image on the right is the augmented reality view via the phone. We can see that a photo is placed on the CVC correctly. When the phone moves, the photo is kept on registered on the marker. Having larger capacity, we can associate more digital content with the marker.

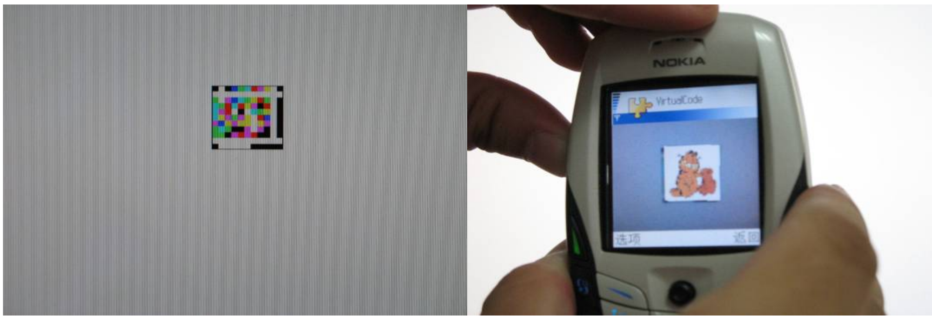

Figure 2. Augmented Reality with Color Visual Code

Conclusion

We have designed a color visual code and used it as an augmented reality interface for mobile phone. Our technique is useful for accessing augmented information. For example, we can print the CVC with an article on newspaper, and then use our mobile phone to see an augmented 3D model, animation, or video for the article, thus activate our static newspaper. The larger information capacity made it possible to link the marker to more digital content.

Our design for CVC has good scalability. We can increase the information capacity of the code easily, basically in two ways: (1) increase the size of grid, i.e. the width and length of the marker to enlarge the information capacity, which also leads to a larger marker; (2) increase the number of colors. For example, if we increase the grid size of CVC to 22x22 and the color number to 16, the information capacity will be (22 – 2) x (22 – 4) x 4 = 1440 bits. Both ways of expansion require more computation on mobile phones.

References

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Wearable automatic biometric monitoring system for massive remote assistance

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The time required to alert medical assistance after a fall or loss of consciousness is a critical factor of survival. The elderly population, who often lives alone and isolated, is the most sensible to those risks. Researches are going on since several decades to develop smart environment able to track symptoms (Williams, Doughty, Cameron & Bradley, 1998) of such crisis and to automatically alert appropriate assistance in case of emergency (Eklund, Sprinkle, Sastry & Hansen, 2005). Human measurements like body temperature, skin conductivity and physical activity are among the basic signals used to determine a person health and stress. Unfortunately, the instruments and wires used to keep track of this information often limit the mobility and comfort of the user. This abstract presents the development of a very compact monitoring system, based on a set of sensors connected to a remote server via a Personal Digital Assistant (PDA), using local wireless connections between elements (Bluetooth) and WiFi to the distant server. This system also features vibrotactile feedback to alert the user and check his response. We also used WiFi access points and quality of signal to determine an approximate localization of the users within a known perimeter. Such a system is intended to be used as a massive, non invasive, biometric instrument to constantly check the health of a large amount of users over an internet connection.

Embedded system

The embedded system is based on a microcontroller which recovers data from the different sensors and sends information to the PDA via a serial Bluetooth communication. The sensors used in this application are analogical ones related to activity measurement: skin conductivity, body temperature and angular acceleration of the limbs. Measurements are taken through an integrated 10 bits ADC controller of the microcontroller. The system collects and treats the information in order to send it as a formatted data structure to the handheld device through the Bluetooth connectivity with a refresh rate around 200 Hz. The embedded system also includes vibrotactile feedback to alert the user in case of need when an emergency situation is detected. In this case the PDA sends vibrotactile feedback to render onto the user’s skin. The vibration motors are driven by PWM generated by the microcontroller. The whole embedded system is low power consumer (below 1 W) and doesn’t weight more than 10 grams, in order to be easily integrated in the clothing of any users (see Figure 1).

Server/client architecture

Handheld devices connect over a WiFi network to a remote server. Information gathered by the sensors is first processed by a microcontroller embedded in the clothes and forwarded via Bluetooth to the PDA. The PDA performs a first-level analysis of these values and regularly sends information to the remote server. In case of minor troubles (connection lost, anomalous data received from sensors or malfunctions), the PDA software informs the user about the problems and how to solve them. The PDA software is extremely user-friendly and is based on the top of our real-time 3D platform described in (Peternier, Vexo & Thalmann, 2006) to provide a multimedia interface with images and animations instead of plain text (difficult to read on the small embedded display). Server-side, the information is stored in a database and compared with values previously received in order to determine if sudden changes have occurred or abnormal data has been recorded (for example when a user’s temperature is very high or low and his/her movement absent). In these cases, alert signals as well as the user profile and data are displayed on the server screen to inform the server-side assistant and help him taking a decision. By using the WiFi geo-localization system, an approximate position of the user is also given to guide a first aid team to reach the patient. In case of emergency, the server assistant can also try to talk with the user by meaning of a voice-over-IP service (VoIP) and the integrated speaker/microphone embedded in the PDA, or try to wake up the user by remotely activating the vibrators.

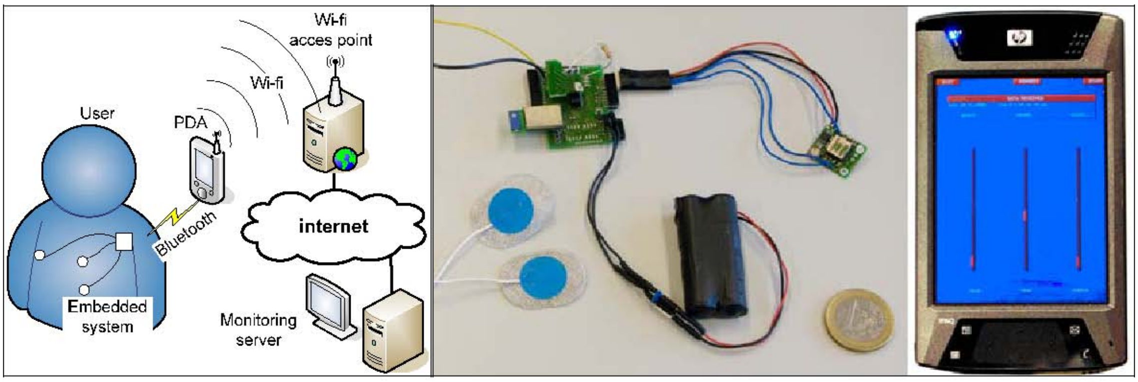

Figure 1. Schematic overview of the system architecture (left), hardware to embed in clothes (center), the PDA software interface (right)

Conclusion and future applications

Our platform is intended to be used in scenarios where monitoring of a large amount of users would be concretely difficult and expensive. Such a system could keep track of their health by offering a partially automatic way to identify potentially problematic cases and requires only a PDA and some non expensive sensors. The use of an already existing WiFi infrastructure also considerably reduces the installation and maintenance costs of our solution: WiFi areas are also more and more widely available and continue to increase in the urban regions (like recently in Paris, with the installation of a large number of free access-points all around the city). The system can also be generalized to all kind of application which requires full duplex telemetry. In a future application such a system will be used in our laboratory to gathers data and send control commands to an unmanned flying vehicle. The goal in this particular application will be to improve presence of the tele-operated system by adding multimodal feedback reconstructed from the different sensors on board.

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