ColoriT: Color Based Image Code Application to Aid in Memory Restoration of Offline Photo Artifacts

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Abstract. Many areas of research have applied memory aid applications to help users remember experiences or enhance learning abilities. Relatively little study however has been done on the use of color based image code as a memory aid. In fact much of what is in use by mainstream media and businesses use mobile barcodes such as 2D image code like Quick Response (QR) code and Microsoft Tag for accessing online content. Part of the freedom of using mobile code is many formats are freely based image code and have accessible API and development kits. Only few are licensed based and are limited to developing usable applications. We investigate a proprietary licensed color based image code using an application we developed called ColoriT (pronounced Color- ət) in hopes of studying its applicability to enhance memory aid when viewing photo artifacts. ColoriT is a simple photo memory tagging concept used to tag offline photos in a pervasive and natural way. By enhancing the user's ability to tag offline photos with memory artifacts we create a tool inspired by storytelling to improve memory aid and overall enjoyment of looking at photos.

Keywords: Memory aid, 2D barcode, Colorcode, Sound artifacts, Color.

1 Introduction

The use of human vision and hearing through natural features such as sound and color have been used to enhance memory cognition in various areas of research. Sound artifacts in particular can be a range of recorded voices, events, and any type of auditory inducer that triggers a memory. The use of color features can be used also to trigger a memory response usually by allowing the user to associate color with events and actions or objects. We take advantage of these natural features and incorporate them into the design of our application which helps to trigger memory responses to unfamiliar photos taken in the past. The advantage of such a system allows elderly for example to remember a particular event or person taken in a photo. Using this scenario as our motivation and inspired by storytelling and online photo tagging phenomenon we present ColoriT (pronounced Color- ət) which allows users such as elderly to remember offline photos taken in the past. Although storytelling applications [5,14] and photo tagging is not a new idea, the concept of digitally tagging offline photos with image code is relatively new. Section 3 explains the methods used in our applications as well as the initial prototyping tools used to study the natural features used in our application.

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1.1 Natural Features – Sound

Sound artifacts are a powerful tool which allows our brain to trigger memory responses. We often associate sounds with known objects in technology and objects existing in nature. Microsoft in particular has adopted universal sounds which most consumers can recognize as starting up a computer or shutting down a computer. The human mind can also distinguish auditory sounds of various objects for example different animals. We know for instance what sound a duck makes or what sound a dog produces. These bits of audio responses are stored in our memory and can collectively be recalled to associate to a particular event or object. Work focusing on using sound as a research tool to study the effects it has on memory have been used extensively. Baldis [1] uses spatial audio to enhance memory in recognizing users during a conference call meeting. A main drawback of this approach points out that visual representations do not affect the outcome in triggering correct memory responses from the test users however participants noted that having visual cues associated with audio is helpful. Dib et al [6] developed sonic souvenirs an application study to allow users to reminiscence on pictures taken in the past using a digital voice recorder. This study revealed that while applicative and enjoyable users did not know what to do with the recordings and often times were not directly tied to associated photos. This disassociation could be improved if sound and images were directly tied together. AudioMemory an application developed by Sánchez et al [16] asserts that sound can improve memory in children who are blind or have residual vision.

1.2 Natural Features – Color

Using color to enhance memory has been studied in [8,15] psychology and is actively used in [2,11,13,17] human factor and visualization studies. Spense et al [15] stresses memory can be segmented into two parts: encoding and recognition phase. Encoding is the process by which information is stored and consequently determines the performance of retrieval. We are most likely to remember an event or object when a triggered response that appears in the encoding phase is seen again in the recognition phase. Color can exploit this area and has been shown to improve memory recognition rates when used with natural scenes. Another use of color has been used in image database retrieval systems [2] a task that is tedious when thousands of images are involved. Color aid has simplified this task by allowing users to use color as an attribute in visual processing of images when searching through the database. Another recent study [13] investigates not only the use of color such as in photos but other memory aid input sources such as text, audio, and social media data. Data is sent to the user's email and allows the user to reminiscence on data received. While useful it is used mainly for online content and would be difficult to implement with paper based information such as paper-based photos.

2 Method

ColoriT is an application based on 2D barcode [12] or also referred to as image code that associates a sound artifact with an offline (paper-based) photo. Our implementation

uses a well-known 2D image code known as Colorcode [3,4,9,10] however any 2D barcode could be used in the design of our system. However, like sound memory applications that help to trigger memory color associations can also help in the same way. Accounting for these features, we adopt the natural beauty of Colorcode to appeal to the human senses more than black and white based code in the design of our application. Figure 1 below describes the process of ColoriT.

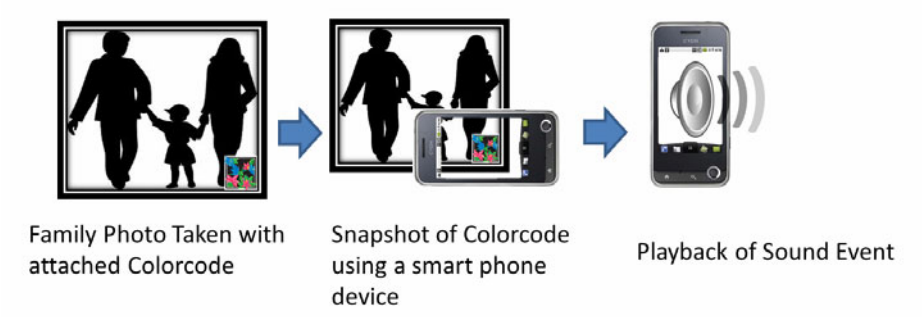

Fig. 1. (From left to right) Process of using ColoriT. Family photo taken with Colorcode attached, Captured using a mobile smartphone, sound events are played back.

The first process of ColoriT extracts the data such as sound from the code captured from the mobile phone. In the second process sound artifacts linked with the code are played back to the user. In the final process, unfamiliar photos should be recognized by the triggered memory response to the recorded sound event. While any code can be used in our application colorcode's unique color scheme can be exploited to enhance the user's memory of an event or person. It is important to note that previous studies have shown color is more effective when used with natural verses non-natural scenes. One known problem existing with our implementation is the size of the code. While sound played back does not pose an issue to memory aid, many users may have difficulty in seeing the code displayed on the photo. Several solutions to this have been proposed. To counter this, larger printed code may be used however the size of code should be reasonable enough so not to pose an obvious interference with recognition of contents of photos. We assume users have adequate vision to see the color visual and we test our application with the normal 5x5 size code (approximately 7mm in width and length). Another issue is the continual effect colorcode may have to supplement sound in memory enhancement. While studies have shown more natural scenes are more efficient, we test the effects of the code in both formats (natural and non-natural). Figure 2 shows a sample of codes used in our application.

In figure 2, we include (e) as a reference to what the code might look like in black and white. It was difficult to produce scenes in black and white that were distinguishable at this size and so we leave that portion out of our experiments. Beautifying the code with natural scenes is a trivial task. The process of decoding the code uses hsv color space to compensate for the change in color intensities and we found that neighboring color cells may be overlapped up to 40% without fail to read the code using our decoder.

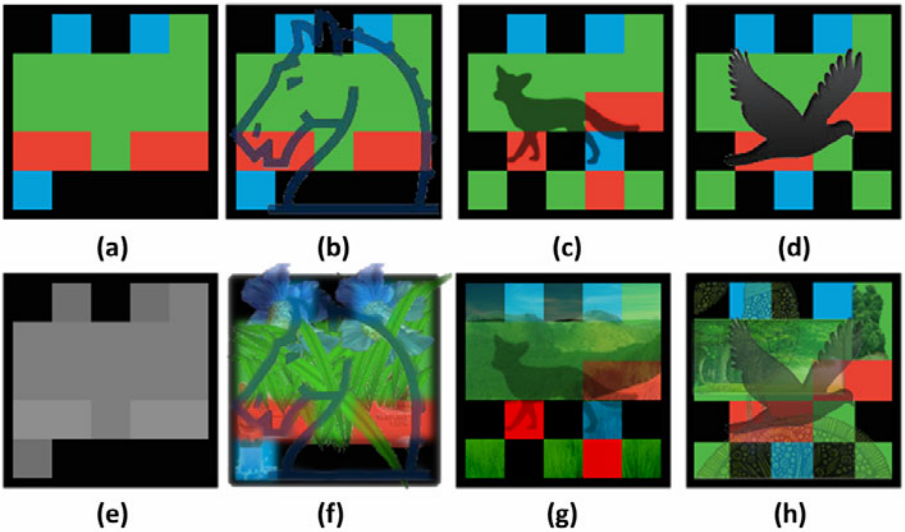

Fig. 2. (a) is an original colorcode, (b-d) are normal codes with added visual object, (f-h) are corresponding visual objects with natural scenes added. (e) shows a grey scale coded block.

3 Experiment and Results

The primary focus of our application is to test its effect on memory enhancement and the applicability of colorcode. We targeted users access to smart phones equipped with a Wi-Fi connection. Also since prior knowledge of sounds heard and known persons in photos taken is not possible to test we overcome by taking a similar approach and still maintaining the concept of our application.

Task 1: We take a random sort of photos with attached codes without natural scenes.

- This task involves using photos and associated colorcodes to test whether or not user can recognize person in the photo.
- 20 photos of five random people are shown to the user. Initially each time a photo is displayed the user looks at the photo, captures the colorcode using their mobile phone and listens to the sound.
- The process is repeated a second time and results are recorded as old or new where old means familiar and new means does not recognize.

Task 2: The same process is repeated with a new list of persons and now using code with natural scenes.

Four users participated in or experiment and revealed that while sound helped with task 1, users stated that added object within the code helped to associate a person in following line of photos. Compared with task 2 users did comparatively equal results. Out of 20 photos in task 1 average was 15 photos correct. In task 2, users did relatively the same with 16 photos correct. When asked what helped to identify with the colorcode was the object placed in the middle. Each colorcode whether with or

without a natural scene contained a small silhouette of an animal. Though inconspicuous, one user stated:

"…having an animal like icon helped to distinguish between colorcodes… I also could associate colored silhouette with a person I saw before."

While it is certain natural scenes with color can enhance memory recognition, we have shown that colorcode is a great application for memory enhancement and tool for looking through paper based photos.

4 Discussion

Initial prototyping and testing of ColoriT shows that users show a better interest in the photo taken. Colors and shapes used by the code can be an element of memory aid if used properly. Actual play back of the sound happening at the time of the photo is also a natural way for users to help remember memories. Though we have shown a robust method for memory enhancing using colorcode, further studies with other media artifacts such as video and comparison with other color based image codes such as Microsoft's high capacity color barcode (HCCB) [7] is needed. The aspect of storytelling is also something to be considered. For example, when users take photographs or are creating a scrap book of photos sound clips and other media can be stored with the associating photograph at that specific moment. Codes can be created to capture the progress of one's work. This is just one avenue ColoriT can be used as ColoriT has presented itself as a natural and pervasive method in the restoration of memory and can be an effective tool to enhance memory response.

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