Paint-It: A Children's Habit Revised

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Abstract. Ambient Intelligence technologies can play an important role in enriching the education and learning experience. Such technologies offer students increased access to information within an augmented teaching environment which encourages active learning and collaboration, enhancing their motivation to learn. This paper focuses of transferring painting into the Ami environment through the usage of an augmented digital surface as a painting canvas, and offering interaction through augmented physical painting material such as paint tubes, brushes, physical palettes of color, etc. This enriched painting experience is targeted to support the development of artistic skills for young artists through employing artistic concepts such as color theory, color mixing for artists, brush type information, etc.

Keywords: Ambient Intelligence, Serious Games, Learning, Painting, User Interfaces for children.

1 Introduction

Undoubtedly painting is considered one of the most joyful activities for children, and it has important impact on child development as well. Research conducted in the field has depicted that cutting, pasting and painting are the most frequently occurring preschool activities [21]. The benefits of painting activities for children are well known in the pedagogical domain and will not be discussed here. This paper aims at transferring the children's painting experience in modern digital environments while maintaining all the benefits and fun of physical painting, by exploiting ambient intelligence techniques. This is achieved through the development of a serious game named Paint-it, which combines an augmented digital surface for painting with physical objects such as brushes, paint tubes, and painting palettes, which maintain in the digital world their meaning and functionality of the physical world.

2 Background and Related Work

Innovative learning environments such us Serious Games (SGs) and simulations provide an applied context in which novel skills can be learned, applied, mastered,

N. Streitz and P. Markopoulos (Eds.): DAPI 2014, LNCS 8530, pp. 164–171, 2014.

integrated and transformed into new concepts and application areas. The fact that people learn from digital games is no longer in dispute. Research [6,7,8,9,10,11] has shown that serious games can be a very effective as instructional tools and can assist learning by providing an alternative way of interacting and presenting instructions and content, with enhanced efficacy over traditional learning. A learner's motivation impacts the learning outcome more than any other factor [5], and SGs seem to be very effective to this purpose [25]. As a consequence, such environments are becoming increasingly popular as vehicles of knowledge transfer and learning. Additionally, SGs have become both a growing market in the video games industry [1,2] and a subject of academic research [3], receiving attention from many diverse fields such as computer science, business studies, psychology, cultural studies, sociology and pedagogy [4].

One of the main characteristics of a serious game is the fact that the instructional content is presented together with fun elements. Such a game makes learners become personally involved with playing in an emotional and cognitive way. By engaging learners emotionally and cognitively, attention and motivation are increased, thus supporting learning.

The usage of ICT technology to offer entertainment painting experiences to children has been considered in the past in a number of different variations. A collaborative, computer-based finger painting program for children has been proposed in the past facilitating an input surface called MultiTouch Surface (an input device that is separated from the computer screen used to transfer signals on a pc and then display the results on the screen) [24]. The evolution of ICT technology and its penetration to everyday activities has today made this form of painting available through mainstream devices such as smart-phones and tablets.

This paper propose a novel form of digital painting where traditional painting materials reappear and play a crucial role in the way that children understand and interact with the application.

3 Building a Collection of Augmented Physical Objects for Painting

The Paint-it system builds on the Tag recognition facilities offered by the Microsoft Surface SDK and the Samsung SUR-40 Microsoft Surface device to create a number of augmented physical objects to be exploited by children while painting (see Fig. 1). These objects either emulate the feeling of painting using actual art supplies or act as easy to understand and use control elements (physical game controls).

Brushes are an important tool for painting. There are different shapes and sizes of brushes. A number of different brushes are available in the Paint-it application (see Fig. 1 section A), exhibiting different behaviours depending on the blob tracking capabilities of the device. More specifically, the blob that the brush creates when placed on top of the painting surface is used to produce the brush size used. This allows starting a stroke with a large stroke weight but adjust it accordingly while moving on the surface by simply reducing the pressure applied on the brush. In this sense any size, filament and shape of brush can be used. Currently, a set of children's painting brushes are used in Paint-it.

Fig. 1. Collection of augmented physical objects for painting

A painting palette is the item used by children for mixing colours. The augmented palette used by Paint-it is a standard wooden palette with slots in the areas where colours are placed or colour mixing occurs (see Fig. 1 section B). When placed on top of the surface, the device presents the available colours for mixing through the slots. Children can therefore select and mix colour from their "magical" palette of colours that becomes alive when placed on the surface.

Learning colour mixing is an essential part of the educational benefits of painting. Paint-it aims at facilitating this learning curve both through the palette (mixing colours using the palette) and through the selection of paint tubes so as to mix or create a colour. To do so, a collection of tagged painting tubes were created (see Fig. 1 section C). Each of these tubes can be selected as colour when placed on the surface or mixed with other tubes when selected concurrently.

Printed tracing sketches are introduced in the Paint-it application for supporting children's typical colouring activities. Sketches can be downloaded from the internet, printed on transparent film and tagged (see Fig. 1 section D). Tags are used so as to move the painting canvas together with the sketch (for example when a child rotates the sketch, the painting canvas get rotated accordingly) to select the desired sketch and then paint on top of it.

Paint-it also provides a set of augmented physical objects that act as control elements and therefore provide access to the functionality of the game (see Fig. 2). Several control elements are employed: (a) a **Canvas** representing an empty painting canvas, a Palette representing the color mixing palette, (c) a **Transparency** wheel rotated to adjust the transparency of brush strokes and (d) a **Color wheel** offering access to a color wheel where children can make their first steps into color theory.

Fig. 2. Collection of augmented physical objects acting as control elements

4 Paint-It

Paint-it aims at creating a pleasant and joyful application for children that could act both in favour of entertainment and learning. In Paint-it, playing gets the primary focus, while learning happens seamlessly through mixing and pairing colours to achieve the desired by the game results. A typical instantiation of the game is presented in Fig. 3. Children have the option to select among a number of different sketches, which are contained in the application's library bar. The library bar only requires that the children navigate within the collection and no text is used. The selection of a sketch from the collection results in displaying on the surface three items. The coloured sketch presents to children the desired outcome, the black and white canvas define the area to be painted, and the palette is meant to be used for colour selection or colour mixing (taping a colour results into selection, tapping another one results into mixing). Children should use their painting palette to generate the colours presented on the completed sketch, and then use their physical paint brushes to fill the area of their canvas. Alternatively, colour selection and mixing can be performed by placing paint tubes on the surface. When the physical palette of colours is placed on the surface, it replaces the digital one.

Fig. 3. The Paint-it variation for children

The full range of facilities provided by Paint-it include: (a) the colour mixing palette with two different instantiations (a digital mixing palette and a mixed reality physical palette), (b) a collection of sketches offering a variety of alternatives, (c) an unlimited collection of printed sketches created by end user , (d) a colour wheel to help children understand the fundamentals of colour theory such as primary, secondary and complimentary colours and (e) a transparency wheel for experimenting with the overlay of transparent over opaque colours.

Paint-it is currently deployed for demonstration purposes on a Samsung SUR40 [14] at FORTH-ICS Ami facility [13]. Fig. 4 presents Paint-it for children running on the aforementioned device, showing the use of the presented physical augmented objects.

Fig. 4. Paint-it for children on a Samsung SUR40 Microsoft® Surface® device

5 Implementation

The implementation of Paint-it was conducted using Microsoft Visual C# [15] and Microsoft Surface 2.0 SDK [16]. The painting canvas was based on one of the control elements provided as sample by the SDK. The built-in tag recognition facilities provided by the SDK were used, and all physical items were tagged using the tag series supported by the device. Knowledge of colors, pigments and paints was modeled in the form of an ontology that has been defined using RDF [17] and was developed with the Protégé ontology editor [18]; SemWeb [19] was adopted for querying the ontology using the SPARQL syntax [20]. Color space transformations for the conversion of color representations between different color spaces and mixing algorithms in a linear color space for reproducing actual pigment mixing were developed in the form of class libraries to be used by Paint-it.

6 Heuristic Evaluation

Heuristic evaluation was adopted as first evaluation method for Paint-it. It is one of the most popular usability inspection methods for identifying usability problems in a user interface design. Heuristic evaluation involves an inspection from a small group of expert evaluators who examine the interface and judge its compliance against recognized usability principles (the heuristics). The evaluation of Paint-it was conducted by three usability experts based on ten general heuristic rules [22]. A scoring scale from 0 (not a usability problem) to 4 (usability catastrophe) was used [23]. In total, nine issues were identified and the most critical are presented below:

- Issue 1. Severity score= 3.5:
  - Problem definition: In order for children to start painting they should place the Paint-it tag on the surface and then select the collection to get access to ready to use sketches. This is too complex for young children especial under the age of six.
  - Suggestion: Consider having the collection of sketches active on the surface when the application starts.
- Issue 2. Severity score= 3.5
  - Problem definition: It is not certain that children can understand what is written and then use the tag's menu.
  - Suggestion: Consider eliminating the tag and the menu and don't present action buttons.
- Issue 3. Severity score= 3
  - Problem definition: The way that the palette is working is misleading (in order to mix colors users should select the color and then select one of the mixtures of the palette.
  - Suggestion: Color mixing should happen silently. When a child selects a color the paint brush is filled with that color. When another color is selected the brush is filled with a color resulting from the mixing of the previous with the current selection.

- Issue 4. Severity score= 3
  - Problem definition: It is not clear to children how to clean their brush.
  - Suggestion: Provide a metaphor such as a glass of water that when touched clears the currently created mixture.
- Issue 5. Severity score= 2.5
  - Problem definition: A palette of color is available both on the surface and on the canvas. This sometimes is confusing.
  - Suggestion: Consider providing only the large palette of colors and remove the one from the painting canvas. A metaphor such as a glass of water that when touched clears the currently created mixture.

7 Discussion and Future Work

This paper has presented the development and instantiation of a painting game for children. Several augmented physical objects were employed to produce a more joyful and playful environment and to emulate aspects of the actual painting process. The main underlying objective was assisting childrens' development and facilitate learning through experimentation which is considered an important part especially for the preschool age. Regarding future improvements, the results of the heuristic evaluation are going to be addressed prior to conducting larger scale user-based evaluation with children.

Acknowledgements. This work is supported by the FORTH-ICS internal RTD Programme 'Ambient Intelligence and Smart Environments'.

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