Collaborative Story Telling through Tangible Technology

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ABSTRACT

The ability to deliver stories - both verbally and visually - is one of essential skills for children as it can inspire them with creativity and develop communication skills. Although numerous ways to convey stories have been introduced with the rapid evolution of the technology, most of these are not suitably designed for children to use. Being able to come up with a new stimulating interaction for story telling can certainly help children enjoy stories and collaborate with the others.

In order to achieve the goal, it is important to actively involve children during the process. Children are normally lively so they like to be physically engaged. For this reason, a promising means is Tangible User Interface (TUI) which enables them to interact in a natural way of granting physical involvement. The substitution for Graphical User Interface (GUI) does not only include children enthusiastically, but also encourages their creativity.

However, there are a huge number of possible TUI designs from which many engineers and researchers have put a lot of effort and money into research and development to find the best means to help children create and share their stories. In this paper, a wide variety of ways to solve the problem using TUI will be studied in terms of challenges, approaches, methodologies and findings.

Author Keywords

Tangible Interfaces; Storytelling; Children; Puppetry; Animation 2D; Interaction Design; Creativity; Narratives; Game Play; Tangible Interaction; Ambient Media; Context of Use; Mobility; Augmented Reality; Tangible Cubes; Edutainment; Drawing; Evaluation; Mixed Reality; Participatory Design.

INTRODUCTION

Storytelling is an extremely important experience for children to improve creative communication skills since they build their own stories using imagination and deliver both verbally and visually. Helping them develop exuberant imagination necessitates an appropriate system interface designed for the purpose. Thus the system equipped with the interface is of vital importance in educating children.

In order to attain the aim, Tangible User Interface (TUI) has been introduced, replacing Graphical User Interface (GUI). The benefits of TUI designs for storytelling have been demonstrated by a number of studies [4, 6, 7]. The experiment in [7] showed that drawings from children who interacted with TUI were much more detailed and complete than those interacted with GUI, proving TUI tends to perform better children development than GUI.

However, each child has their own unique behaviour, which means some unexpected activity patterns demand to design more sophisticated system. A failure to put them on a steep learning curve may actually lead a system to be a barrier to childhood education.

In regard to the technical demand, a number of different approaches have been found. For instance, a puppet-like tangible interface can be used to overcome the problem [1]. Alternatively, boards [2, 3, 4, 5] or cubes [6, 8] can be substitutes as children are already familiar with those interfaces.

This report will study the literature in this field, discussing the approaches taken to determining which TUI interactions to use. Also, designs of the system and methods for analysing the effectiveness of them in terms of children's engagement and attention will be examined.

CHALLENGES

Ease of Use

According to [1, 8, 9], there are three issues that must be taken into consideration if it is to ease the use. These are: a natural interaction design, freedom of the user movements and a high degree of detection accuracy. All developers in the nine papers believe that the first issue, a natural interaction design, is the most crucial aspect about TUI system design.

Collaboration

As a system of storytelling is mainly used in class, it is important to be able to engage a group of children so that they can work collaboratively. The interaction should be designed in a way that is more legible to audiences with benefits in terms of theatricality, making children pay attention and being learnt by spectating [9].

In addition, since every child thinks differently, it is possible for them to come up with several results when they are mutually involved. Thus, a system should be able to offer a wide range of choices rather than just single event. In this manner, it fosters children's creativity while they work collaboratively and create numerous stories.

Environmental Requirement

It is significant to meet the environmental needs. Especially, TUI demands more environment requirement than conventional systems. The main issue is a space requirement. Some TUI systems are involved with a broad range of body gestures, which draws back more than GUI in concern of space availability. Also, the system may be situated to more frequent change in size and relocation.

APPROACHES

Familiarity

The developers in [1] believed that most children are already familiar with puppets for storytelling so that it reduces a barrier to the use of their system, iTheater. For this reason, they came up with a puppet-like interface. Puppets are equipped with two infra-red LEDs [1] so that children can freely interact with them as if they play with normal puppets while the movements are being tracked and integrated.

A board type interaction is another solution to gain familiarity because there are a huge number of games involving boards such as chess. This is found in [2, 3] and [5], but they all approach in a different way.

The system of [2], Reactoon, is an authoring tool, which is benefited from the advantages of TUI explained above. It builds 2D animation for a table top with TUI and multi-touch screen [2]. Children can interact with hands to place physical objects on the Reactoon system to produce their own stories. The goal of the work is to keep the way children play with their toy box as much as possible with the aid of TUI, yet providing much more resources. As this requires natural and physical actions from children during the process of story creation, they can simply and entertainingly be participated.

The format of [3] is a two-page book resembling card playing, where picture cards are placed on the left side and an animation is shown on the right side. Children select and place picture cards that look appropriate for their stories up to 15 on the platform. Each picture card represents a single action or an object and when it is placed on the platform its oral and visual feedback is provided to the users.

PageCraft [5] allows children to interact with building blocks and shapes on a board, which is similar to the way they play in many activities. Then the position and movement of them are read by tagged sensors. Instead of using the mouse and keyboard, the system provides children with hands-on interaction by using real building blocks and character figures [5]. Additionally, visual and audio feedback supports children in the use of the system. For example, when blocks are placed on water splashing sounds are produced [5]. In this manner, it is possible to circumvent the interaction design problem.

[6, 8] tackle the solution of a board type interaction. The developers believe that a cube is an intuitive and simple object that people are familiar with since childhood. Using a pair of cubes manages the storytelling process.

In [8], the first cube is designed to navigate through different scenes of the story while the second cube is used to choose items. The developers have these two main reasons for choosing cubes as the system interaction. These are: cubes are stable in terms of physical equilibriums and they can be easily piled together to build a compact and stable structure [8].

Accuracy Enhancement

The interaction of [8] involves tracking cubes which have six different markers on each of its surfaces. While the users are holding a cube, it is possible that markers may be covered with the users' hands. In order to surmount the problem, the developers designed an algorithm to track their 3D cube. As the position of each marker relative to one another is known and fixed, it is possible to identify the location of cubes as long as any of the six markers are found.

The algorithm consists of four steps. (1) Detect all the surface markers on cubes and save the information in a corresponding transformation matrix. (2) Determine a marker that has the highest tracking confidence. (3) Identify its surface ID: top, bottom, left, right, front, or back (see Figure 1). (4) Calculate the transformation matrix from the coordinates of the market.

The minimum requirement is one visible surface of a cube. Thus this guarantees continuous tracking even when the users' hands conceal parts of cubes during interaction.

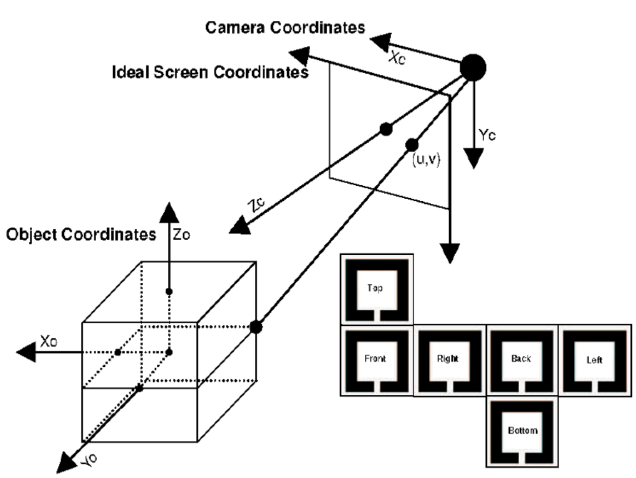

Figure 1. Coordinate system of cube tracking system

Involvement

The focus of [9]'s research was to propose an interaction that supports collaboration in larger groups, potentially involving the whole class. In order to involve a huge number of the users at a time, a large display screen was needed so the developers of [9] decided to achieve the goal using a projection screen. Moreover, the size of an interaction had to be big enough for children to work collaboratively. This goal could be attained with the aid of pressure sensors placed under a carpet. The benefit of these two decisions was that they were cost-effective and easy to be implemented.

Firstly, eight sensors were located around the carpet so that standing on either of the sensors at the front would zoom in while standing on those at the back would zoom out [9]. Multiple sensors could be triggered at a time so that if both sensors on the right were triggered, it would move to the right fatser.

In consideration of deciding how many sensors should be required, the developers agreed to use more sensors around its edges for better collaboration. With this new design, when two children trigger all sensors on one side, they can navigate faster, which encourages collaboration. When a single child should be able to use the carpet he/she would naturally stand in the centre of a side, which implies use of an odd number of sensors [9]. Therefore, the minimum number of sensors to meet both requirements is three so the final design comprises twelve sensors in total (see Figure 2).

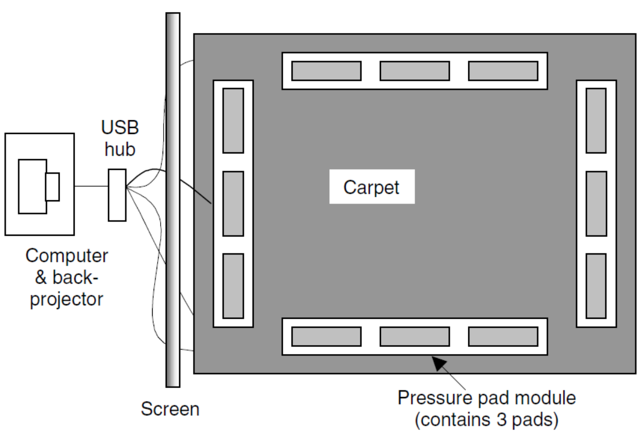

Figure 2. Layout of KidPad

Diverse Activity Encouragement

[3] proposed an interaction that allows children to come up with a number of different stories with the same resources. The system demands the users to sort logical sequences in a more practically augmented means. When they place cards on the platform, the system detects where they are placed and support connections between them in the order of placement. Once the story is ready, the system follows the order of placement and produces audio and visual feedback of each card. Therefore, it is possible for children to take a turn and create a different story using the same resources and such diverse options support collaboration.

Portability

The developers of [5] designed the system so that the components can be fit into a soft carrying case. This enables children to carry it around easily and take it anywhere they want.

[9] is designed in a way that it is easier to deploy in a classroom. The pressure pads which are grouped into blocks of three are encased in plastic so that they can be rugged [9]. These blocks can be laid on the floor as needed, enabling the size of the carpet to be adjustable towards on changing spatial condition.

Furthermore, the blocks do not necessarily have to be deployed in a rectangle shape. They can be laid out in any patterns such as in a long line, or in a star to transform the style of interaction [9]. Also, the sensors can be covered with paper, on where children can paint.

METHODOLOGIES AND FINDINGS

[4] conducted several experiments to find out the most effective session for storytelling from four sessions. They were: speech only, with a book, with a puppet and with a felt board. Participants included 12 children enrolled in the two year old classroom in an early learning centre [4]. In all sessions, the teacher delivered the same story then sometimes asked the children to finish the sentence. Only the tools used during the sessions were changed.

They compared participation numbers produced by each session. They found that the session with a book had the lowest participation numbers while the session with a felt board produced the greatest participation numbers (see Table 1).

During the observation of the session with a book, the children appeared to experience the most difficult narrations. This is because the pictures kept them focused on the contents of the page. The results suggest a strong correlation between creativity and kinaesthetic movement.

Coding	Session 1 Speech Only	Session 2 w/ Book	Session 3 w/ Puppet	Session 4 w/ Felt Board
Original	14	9	15	21
Popular	9	4	2	8
Total Fluency	23	13	17	29

Table 1.Ideational Fluency Scores

[7] presented a study a comparison between the quality of each experience by TUI and traditional interfaces. The study involved two groups of kindergarten children. The first group interacted with tangible interface, which consisted of a large physical tooth on where the virtual germs were projected and a tooth brush about 70cm [7]. The children were asked to brush the germs. The second group played a computer game that had a tooth with germs moving on its surface. The children were expected to clean it by using the mouse.

After the interaction of both groups, the children were individually asked to draw what they had had experienced. Children in the first group drew not only the tooth but also the surroundings and most of them also drew themselves holding the toothbrush (see Figure 3). In contrast, none of the children in the second group drew themselves, but only the tooth that they had seen in the game (see Figure 4).

The drawings from the first group were much more detailed and complete. It was suggested that an interaction with TUI makes children feel part of the story since they get a higher chance to have a more physical experience [7]. Contrariwise, a traditional interface leaves the users as mere observers.

Figure 3. Picture drawn by a child in the first group

Figure 4. Picture drawn by a child in the second group

FUTURE WORK

[1] uses virtual characters when the movement of puppets is tracked and integrated. The ability for children to customise the characters can be introduced so that the system can interest children even more. Also, the creation of contents such as background and sounds is believed to enhance the design of the system.

Moreover, currently, [1] requires smooth movements of the puppets so that the system can track infra-red LEDs. Furthermore, improvement of IR tracking has to be made in order to enable detection of vigorous movements. This certainly should be developed further so that the user interaction is not restricted.

There is a limit to the surface area in [2]. A future research on gesture recognition may be able to replace some of the tools, saving space as well as interacting even more naturally.

[5] only consists of building blocks and shapes. Extensibility of tangible units such as those with lights will be advantageous in terms of keeping the users excited. The number of characters that can be tracked at the same time is currently six, which still needs an increment.

Generally, the users do not tend to pay attention to the written instruction. Thus, a further work on converting the instruction into an audio-visual format is believed to be effective. This can prevent the users from mishandling of the cubes.

As soon as the user mishandles the system, it will be more useful to generate a warning message such as “Please don’t cover the top market of the cube.” than to show the icon on the screen since many users do not understand the reason [8].

SUMMARY

Designing a system using tangible user interface does get a higher chance of producing a more effective and collaborative storytelling for children than a graphical user interface system.

However, TUI also provides a number of obstacles that the developers have to overcome to create systems that children can enjoy and work collaboratively for storytelling.

The literature shows a variety of approaches to coming up with the best TUI design associated with storytelling for children. They include puppets, boards and cubes, which have their own benefits to the design purpose. Similarly, different methods and algorithms are made to create and analyse the systems.

As the technology develops, these different approaches may merge together and become as one common method or the number of approaches may increase. It appears to be that there is no certain solution that possesses all the advantages of TUI over GUI. Regardless of the number of solutions, better systems will be developed and introduced to boost children's creativity and develop communication skills via storytelling.

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