Mixed Reality Entertainment and Art

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***Abstract*— Social and physical interactions are new paradigms that outline the vision of the next generation of entertainment. We can provide these interactions through employment of technologies such as mixed reality to merge the human physical world with the virtual game world. However, there are a few obstacles in achieving physical, mobile, tangible and social interaction for people's entertainment. The authors had organized a workshop on this topic of "Mixed Reality Entertainment and Art" at the ISMAR 2007 conference in Nara, and the presentations are summarized in this paper. Furthermore, the authors detail their related systems, including BlogWall, MediaMe, and Shared Design Space to provide artistic and entertainment mixed reality.**

***Index Terms*— interactive media, interactive art, human-media interaction, mixed reality.**

I. INTRODUCTION

Mixed reality [18], the fusion of augmented and virtual reality, is a technology that allows the digital world to be extended into the user's physical world. Unlike virtual reality in which the user is immersed in an artificial world, mixed reality operates in the user's real world. It allows tangible interaction with 3D virtual objects; by moving a physical object or marker, one can move and interact with virtual objects as if they were real objects in our physical world. Thus, a true tangible interaction between the physical and digital world is achieved.

Mixed reality can be used to develop an almost magical environment where the virtual world, such as 3D computer graphics images and animations are merged with the real world as seamlessly as possible in real time. For example, architects could work on a realistic virtual 3D model on their desk, and then enter the model together to explore the inside of the virtual buildings, surgeons could "see" the inside of a patients body before operating, children could see animals from exotic lands, and play with them in their real physical space, people could play games with each other together with virtual characters or creatures that appear in their real environment.

Hence mixed reality is becoming a highly important component of the future entertainment computing systems. It will allow humans to interact with each other in ways that surpasses the imagination and the scales of interaction with computers will be far beyond the desktop computers of today. It will enable us to create a mystical world that man has never experienced before. There will be applications in a great variety of areas in computer entertainment.

Of late, the developing technology is providing a variety of avenues for innovative entertainment and art. As a topic of research, the technology in entertainment industry is growing dramatically fascinating. There has a great deal of recent researches that examine the deficiencies in present entertainment system. The main deficiency being the partial and passive involvement of people in the play due to the limited access of screen based interaction and secondly the lack of socio-physical interaction between humans and computer entertainment systems.

The advances in mixed reality entertainment have also led to new forms of technology-enabled media art, culture and performance which have created new forms of entertainment that attract, immerse and absorb their participants. The phenomenal success of such a "culture" to initiate a mass audience in patterns and practices of its own consumption has supported the evolution of an enormously powerful mass entertainment, digital art and performance industry extending deeply into every aspect of our lives, leading further to major societal and business contacting changes.

Furthermore, combining media art, culture, and technology allows the research to generate results in the commercially high impact fields of entertainment and communication. New forms of mixed reality technologies together with media arts and cultural heritage are another innovative introduction for new type of entertainment. Our research focuses primarily on combining those fields to achieve the expected goals. For instance, MediaMe, BlogWall, and Shared Design Space are combinations of art, culture, entertainment, and technology.

II. SUMMARY OF PRESENTATIONS AT ISMAR 2007 WORKSHOP

ISMAR 2007 workshop explored and discussed the latest research and new paradigms of mixed reality for entertainment and art. Following presentations from ISMAR 2007 [15] workshop has been published in the special issue of IJVR (Vol. 7, No. 4, December 2008).

Huggy Pajama is a novel wearable system aimed at promoting physical interaction in remote communication between parent and child. This system enables parents and children to hug one another through a novel hugging interface device and a wearable, hug reproducing pajama connected through the Internet. "Augmented Exhibitions Using Natural Features" discuss a system that enables museum exhibitions using natural features instead of calibrated fiducials to

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recognize paintings and recover their pose. The ability to augment and annotate exhibits with virtual content represents a potentially powerful tool for museum curators. This virtual content could include background information, schematic diagrams, or labels of individual parts, all spatially aligned with the exhibit itself. “Bridging the gap between real and virtual objects for tabletop games” present a collaborative tabletop game which combines both the real and virtual world. The main motivation for this game was to augment a traditional board game with additional digital content. wIzQubes™ is a novel tangible interface for interactive storytelling in Mixed Reality. A pair of cubes tracked by computer vision is used to control the storytelling process. The application embeds both the concept of Mixed Reality and tangible interaction. Multiple modalities including speech, 3D audio, 3D graphics and touch are used to provide the kids with multi-sensory experiences in interactive storytelling. "Texture Neutralization for Invisible Object Representation using a Projector-Camera System proposes a novel e-Performance for controlling the surface texture of objects and humans. It presents a method of neutralizing the appearance of an arbitrary object using a projector-camera system. “Mixed Reality Pre-visualization for Filmmaking: On-set Camera-work Authoring and Action Rehearsal” presents an advanced approach that utilizes MR technology in PreViz (pre-visualizing). MR-PreViz makes it possible to merge real backgrounds and the computer-generated humans and creatures in an open set at an outdoor location. "Stylized Depiction in Mixed Reality" discuss the use of artistic and illustrative rendering techniques for combined real-virtual environments. Depending on the type of stylization used, a novel user experience can be created.

Following are the remaining presentations of ISMAR 2007 workshop. "Live Video and Augmented Reality over Internet as Entertainment for Dogs" investigates if video conferencing software, proposedly enhanced with augmented reality games, could be used for remote interaction between dogs and their owners so they could communicate over internet during the master's absence. AR Squash Game is a squashstyle game based on AR technique. The game was made using AR technique to estimate geometric information of images taken from a CCD camera. "Geometry Education using Augmented Reality" explains how Augmented Reality can be applied to help students overcome the difficulties in learning 3D Geometry classes such as Solid Geometry, Descriptive Geometry, and Technical Drawing. The AR 3D Geometry system provides users with such primary functions as constructing some popular 3D geometry types, customizing their attributes, taking geometries to another marker then simulating their intersection. "Creating Emotional Feeling based on AR Game" suggests an interactive horror game using location information and augmented reality technique. The two goals of the project are to provide the game interaction between a user and system by adopting hand-held display and to provide the feeling of bizarre and horror to a user. "Loosely coupled Mixed Reality", a user maintains two realities (e.g. virtual and real) and fuses them in one’s head into a coherent model. “Flow of Enjoyment in the Context of Interactive Installation” presents a new perspective to redefine the technology driven based interactive installation. Paper explores the technological strategies of interactive installation towards creating a creative engagement and involvement of the audience. "Study Of The Dynamic Exhibition Space For Art" present a study for implement exhibition space for fine art and design through the AR. Puni Puni Light is a projector-based Mixed Reality technology where the system gives a small wave effect on the surface of the object on which one touched or spotted. Paper clams that users would enjoy this simple but surprising effect; since people loves soft things. "An Emotionally Responsive AR Art Installation" describes a novel method of combining emotional input and an Augmented Reality tracking/display system to produce dynamic interactive art that responds to the perceived emotional content of viewer reactions and interactions. The aim of this research is to explore multimodal interaction in an Arts and Entertainment context.

We have developed several applications demonstrating how mixed reality can be used to combine art and entertainment. Following sections shall provide a detail explanation of them.

III. BLOGWALL

SMS or short message service is immensely popular among mobile phone users today [13]. The volume of short messages that Hong Kong people sent during the period December 2006 to November 2007 amounted to 3.28 billion, a record high since OFTA (Office of the Telecommunications Authority) started collecting the figures in 2002, translating into an increase of 26% as compared to the same period in 2005 and 2006 [3]. This is a testimony to the immense popularity and the escalation of text messaging. But it is primarily used for peer-to-peer communication.

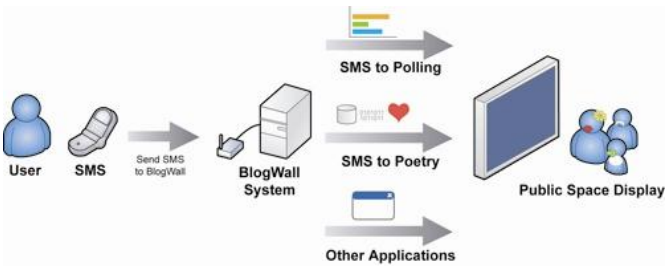

Fig. 1. Concept design of BlogWall

3.1 BlogWall Background

Researchers around the world have being experimenting with different combinations of art, social communication, and mobile messaging. The mobile phone has already been used as a medium of self expression [9]. Ballagas et al. [4] discuss enabling interactions with large public displays using mobile phone. They have used the embedded camera on mobile phones as an enabling technology. Ballagas et al.’s “Point & Shoot” technique allows users to select objects using visual codes to set up an absolute coordinate system on the display surface instead

of tagging individual objects on the screen. Joe Blogg [17] is a public display where users can contribute content by sending messages and images to it using their mobile phones. TexTales [2] is a large-scale photographic installation to which people can send SMS text message captions. It can create technologically supported public discourse spheres in which they can both represent personal views and practice new ways of forming collective opinions. Mobile phone can also act as a controller of a public display, for example in the Blinkenlights [6] project, the upper eight floors of the building were transformed in to a huge display by arranging 144 lamps behind the building's front windows. By using mobile phone users could play a game of "Pong". The BlogWall consists of many of the features found on those systems but it concentrates on promoting artistic and social communication through poetry.

3.2 BlogWall Overview

BlogWall is an extension of the existing text messaging to a new level of self-expression and public communication, combining visual art and poetry. Furthermore it will provide a means of expressing in the language that young people can understand, and the form of social communication, which is an essential part of their lives. The application enables a person not only to express herself/himself artistically but also entertain the masses in a form of digital graffiti. Fig. 1 shows the concept design of BlogWall.

Fig. 2. BlogWall at Singapore Science Centre

Several modes of BlogWall are available which can activate to the requirements of the user. In the basic mode the application will only display SMS on the BlogWall in an attractive way. The polling mode enables the application to gather data from the public. In the poetry mode a poem will be created with the means of the user SMS.

3.3 Poetry Generation

Essentially, most poetry generation so far has consisted of randomly choosing words and making the resulting phrases fit in a predefined language grammar. Such attempts at generating language prose have been in a similar vein as PROSE or RACTER [14]; two examples that exist in publication. These are in turn similar to ELIZA [26] and FRED [8], in their approach, which consists creating prose at random but suited to a grammar template. However, natural language generation which aims to mimic communication between man and machine is inadequate when it comes to generating poetry. Poetry possesses characteristics such as rhythm and rhyming schemes. Furthermore, poems generally do not have clear and well defined communication goals. They rely rather on abstract and figurative language, encouraging the reader to form their own conclusions as to the meaning. In view of these differences, a revised poetry generation model is required. Manurung et al. [16] recently proposed the "Stochastic Hillclimbing Model" which attempts to address these difficulties. In our model, we integrate a number of techniques from different disciplines such as information retrieval and natural language understanding, and augment the system with emotional intelligence to generate a poem which is both meaningful and capable of entertaining the user.

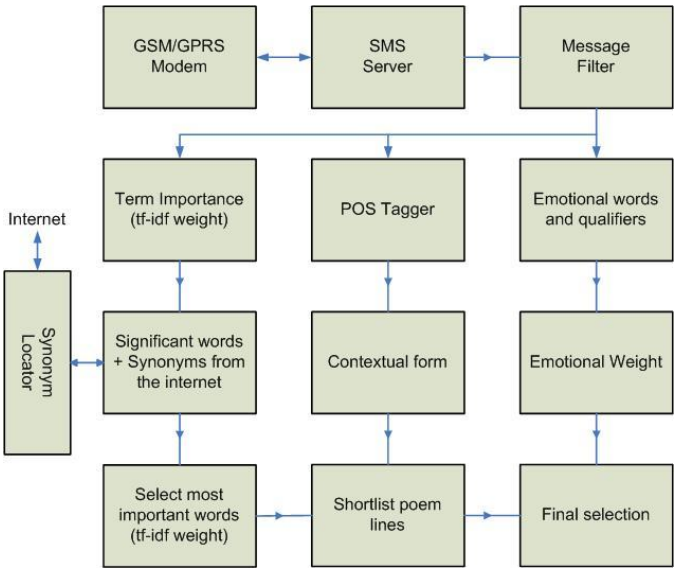

Fig. 3. Poetry generation system overview

The poetry generation process in the BlogWall consists of several stages. The system uses three different criteria to shortlist discrete sets of poem lines. The schematic in Fig. 3 illustrate this process. Three separate analyses are performed on each incoming message.

3.3.1 Term Importance

Given an input message, the words in the message are arranged according to their importance. For instance, in the sentence "I love thunder and rain", "love", "thunder" and "rain" would be the most important words. Because, very common words such as "I", "and", "the" would appear in many of the poems, so they are less helpful in identifying a suitable poetry line. The uncommon words such as "thunder" would be more useful in identifying a suitable poetry line. System also grabs synonyms from the Internet [11] to expand the search criteria. This would enable the system to provide an unexpected and surprising result. The importance of a particular word is denoted by a numerical

weight. This number, called the tf-idf weight, is the multiplication of two values: the term frequency (tf) and inverse document frequency (idf). The weight is often used in information retrieval and text mining.

The term frequency is a measure of how often a term is found in a collection of documents, in this case poem lines. The inverse document frequency is effectively a measure of how rare a particular term is. It is calculated by total number of poem lines divided by the number of poem lines containing the term. Very common terms ("the", "and" etc.) will have a very low IDF and are therefore often excluded from the shortlisted lines. Then TF divided by the IDF is a statistical weight of how important a particular word in the set of poems.

Given a query of i words, the end result is to calculate this weight (w) for each word in every poem line.

$$w_{i,d} = tf_{i,d} \times \log\left(n/df_i\right) \quad (1)$$

Where; $tf_{i,d}$ is term frequency of the i^{th} word in each poem line in a set of d poem lines. n is the total number of poem lines. df_i is the document frequency of the i^{th} word.

For each word i, the system then returns the poem lines such that $\sum w_{i,d}$ is maximized.

3.3.2 Word sense disambiguation

One key success factor of the system is the ability to make meaningful connections between user input and the poem lines in the database, resulting in an original and meaningful poem. For this purpose, word sense disambiguation is necessary and this is the second part of the analysis. The system uses a part of speech (POS) tagger for basic disambiguation. The tagger used in the Blogwall is the English POStagger [25], primarily for the tagging speed and ease of integration.

The input message and each poem line in the database are tagged using a POS tagger. In order to avoid poems that do not make sense, these tags are used to pick only those poem lines which use a particular keyword or its synonym in the same sense as in the input message.

3.3.3 Emotional Weight

Analogous to the tf-idf weight described earlier, which ranks words in the input message according to importance, the third analysis is the calculation of an emotional weight. This attaches a numerical value to the mood or emotional content of the message.

The system maintains a database of words that can influence the emotional state of the sentence, along with the corresponding weight of the word along two axes: degree of arousal, and degree of pleasantness. The weights are modeled after the Russell Dimension for emotions [22]. In addition, a database of qualifiers and their corresponding multipliers is also maintained. For instance, the phrase "not happy" will result in the weights of the word "happy" being multiplied by negative one which will yield in a result closer to the emotional weight of "sad".

The system thus analyses the input message for such emotional words and qualifiers. Ultimately, the message will be attached a numerical value denoting the emotional weight. In a similar manner, all the poem lines in the database will also be assigned a numerical emotional weight. The system will then shortlist lines with weights that are closest to the weight of the input message.

3.3.4 Final Selection

These three processes are important to the final output. In the first case, the significant words are augmented by fetching synonyms from the internet. A second round of calculation of tf-idf weights results in the most important words from this combined set. These words, together with the contextual tag from the POStagger are used to shortlist poem lines. Only the poem lines which contain these words used in the same context are shortlisted. The final output to the user will be the lines that are closest in emotional weight to the input message.

Suppose the user sends the SMS "Life is good, I am happy";
Output from the POS Tagger;
Life/NN is/VBZ good/JJ. I/PRP am/VBP happy/JJ

where;

NN	Noun, singular or mass
VBZ	Verb, 3rd person singular present
JJ	Adjective
PRP	Personal pronoun
VBP	Verb, non-3rd person singular present

Emotional weight of the SMS;

x-value -	Degree of pleasantness	1 (good) + 1 (happy) = 2
y-value -	Degree of agitation/anxiety	0 (good) + 1 (happy) = 1

Important words selected are "life", "good", and "happy" based on term importance. The system searches synonyms for each of the selected word. For example synonyms found for word "life" would be; living, aliveness, animation, living, etc. Similar set of synonyms are found for "good" and "happy". For each set of words system try find a suitable poetry line. For example for the word "life" the output of the system is;

That love is life
The sprit turns away

Based on the emotional weight of the SMS system has chosen; "That love is life".
The final poem create by the system is;

That love is life
am I an upright man?
You leave me, leave this happy vale

IV. MEDIAME

Computing technologies are increasingly being used to support new forms of entertainment and creativity. Creativity,

art, and digital entertainment systems provide futuristic new media forms. MediaMe is a media interactive art work which comments on the bidirectional relationship between people and the media through the use of a real-time video mosaic. It also provides the means to educate the masses while entertaining them. This will also bring new ways of communication between people and media, and new forms of social, educational, and cultural interaction.

MediaMe displays a captured image of a person as a video mosaic made of hundreds of videos. We literally turn the body into videos, which enable an individual to explore different cultures. Videos are continuously arranged in real-time to form a mosaic representation of the background to provide meaningful contents, such as cultural and historical media. When no image is captured by the system, MediaMe activates and reflects the media itself by creating a mosaic of cultural and historical content. Fig. 4 shows the concept view of the MediaMe system.

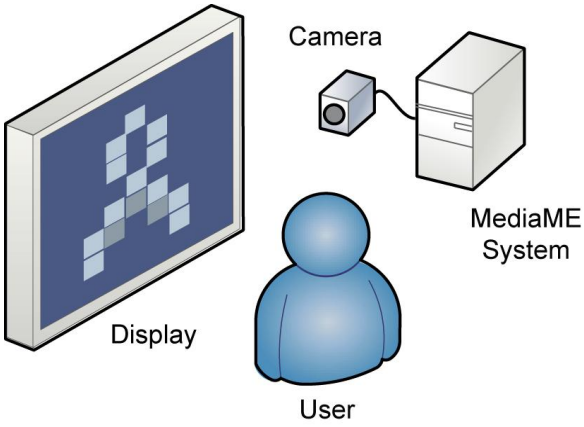

Fig. 4. MediaME concept view

MediaMe can be considered as a new form of personal media where a person can create and broadcast his/her own customized contents as image elements. For the current version of MediaMe, we have used movies of Sri Lanka in religious, cultural, and historical themes to create a meaningful video Mosaic. This system can also be used for educational purposes in an interactive way, i.e. exploring national heritage of Sri Lanka. We are also extending the system for various other cultures.

The image of the person, who stands in front of the blue screen, is captured by the camera. In the system initialization process the average color of the background is computed and it is used to remove the background from the extracted video frame. The foreground is segmented to rectangular areas and average color of each of them is calculated. The average color is used to find a matching video clips from the video databases, which are pre-analyzed and organized based on their average color. Since the system has only a finite number of videos, some amount of color correction is applied to the selected video clips in order to attain the realistic look and feel. The background of the original video is removed and replaced with larger tiled set of videos. These videos are randomly selected from a video database. Finally, the background and the foreground are combined to create the mosaic. An electronic projector projects the final video mosaic on to a large screen right before the person.

Fig. 5. MediaME at Singapore Science Centre

Unprecedented growth of digital media content has created new problems to solve as well new opportunities for novel applications. We have extend our work on MediaMe to develop a novel video browser to solve some of the existing problems in the field of video browsing, as well as to provide users with an engaging and entertaining experience on browsing video contents.

4.1 Novel way of browsing videos

The plethora of multimedia resources at the disposal of general public has led to the development of a variety of media browsers. However these media browsers fail because of their various shortcomings. Thumbnail representation of the media is not very helpful to the user. Another major problem of these browsers is that it is difficult for the users to comprehend the overall outcome of a search. How exactly the videos related to the phrase given by the user is not obvious. Some of the newer media browsers indeed provide many helpful features but most of them are still locked with in the thumbnail framework. Online media organizers such as Google videos [12], YouTube [28], 3WNews [27], VIDSEEK [20] all provide 2D thumbnail view point. They are limited in providing connectivity between individual videos. Though some of these browsers have some unique features, like organization feature in Photo Mesa [5], they still fail to provide a complete engaging experience. 3D Picture Browser [1], PicLens [19], and TiltViewer [24] provide very innovative and easy to use interfaces. Photo Tourism [23] provides a 3D sense of viewing the content. The system is designed for photographs and the main purpose of the system is to represent a scene with photographs taken from various angles. All these interfaces are in 3D space but designed to work with images. MediaMetro [10] is a system that provides an interactive 3D visualization of multimedia document collections using a city metaphor. To provide the users with an engaging and entertaining experience browsing video content,

we have developed a 3D Video browser, a browser which launches a new approach of browsing videos to the users.

4.2 3-D Video Browser Overview

The 3-D video browser emulates the model of a universe in its functionalities. The videos are floating around in a 3-dimensional world just like the heavenly bodies in our universe. These randomly flying videos can be played in full screen upon selection. The browser is being supported by a video server which contains the videos for the browser. This interactive browser is dedicated to the development of an extremely pleasant and engaging video browsing service.

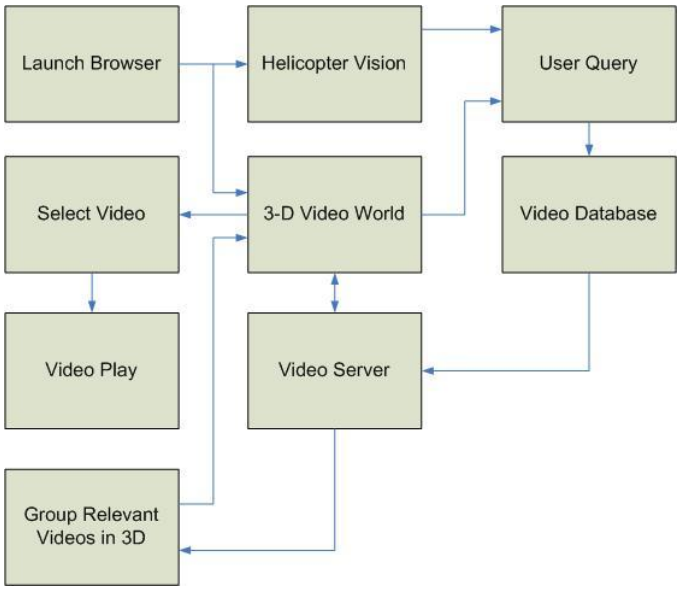

Fig. 6. 3-D video browser working model

Fig. 6 illustrates how the 3D video browser works. Upon launching the browser the user sees a 3D world of videos and is allowed to navigate in the world to explore it. Helicopter vision is used to give control to the user to navigate the world of videos which is being implemented using the video pipeline of OpenGL The striking aspect of this 3D world of videos is that the videos are continuously playing in the 3D world and are not just a single frame, which usually is the case in today's video browsers. All the videos in the system have been tagged based on their content. Currently the video has to be tagged manually but we are planning to experiment with automatic tagging in feature versions of this system. These tag information is stored in a database and is used in user searches.

4.3 Interacting with the 3-D Video Browser

When the user types in keywords, all the videos become organized based on the keywords entered by the user. The movement of the videos can be considered as a swarm of bees. The videos that have a very close or strong relationship to the keyword get closer to the core of the keyword. The weakly related videos go to the edge. And the videos that have no relationship to the keywords move to the background. Suppose the user enters words Paris and love, videos that are closely related to Paris group around the word Paris. These videos may be video taken in Paris, climbing the Eiffel tower. Videos grouped around word love may be videos of weddings, marriage proposal or couple in love. The intermediate space between Paris and love grouping get filled with videos that are tagged with keywords Paris and love. They could be video of a couple taken in Paris, or getting married in Paris. The videos are not stationary. They move around like swam of bees. But they always keep their relative proximity to the grouped keyword as shown in Fig 7.

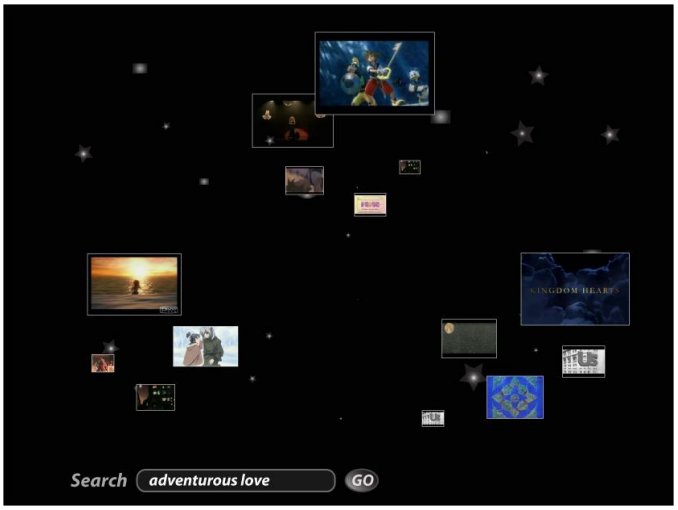

Fig. 7. 3-D video browser

The user can freely navigate through the large number of videos using the keyboard keys. The allowed moments are forward\backward (surge), left\right (sway), up\down (heave). The movement is similar to that of computer games. The user can zoom in out of any video in the 3D space. The user can select a video clip in the 3D space using the mouse. The selected movie will come forward and will take most of the display screen if the original video size permits it to do so. The viewing of the selected movie clip is similar to that of any movie player available today. Other possible details of the movie such as title, description, keywords, owner, etc. can also be viewed at this stage. This browser aims not only to engage and entertain the user but is our attempt to revamp the existing browsers and usher in a new era of web surfing.

V. SHARED DESIGN SPACE

Shared Design Space is a collaborative tabletop environment designed for sketching and brainstorming. Multiple people can stand around an interactive table while interacting with digital pens. All participants have their own private workspace; they can pick up digital images, placed on the table, and move them to the private workspace using the stylus. In our demo, we implemented a collaboration application with four different workplaces. Individual sketches can also have embedded pictures and videos that have ink annotations added to them (see Fig. 8). These annotations remain on the widgets as they get moved on the table surface for further discussion.

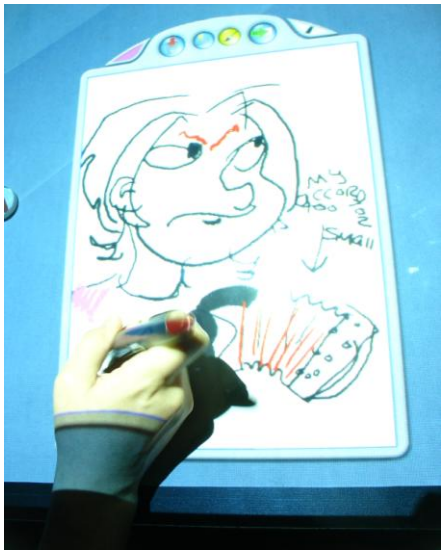

Fig. 8. Shared Design Space in Action.

The participants can draw their strokes of different colored ink onto the private canvas. Objects on the table can be moved by dragging-and-dropping, but this can cause performance problems over long distances. If people have to move the pen over a long distance, they often lift the pen, which drops the dragged content. Therefore, we use the pick-and-drop metaphor developed by Rekimoto [21].

Fig. 9. The color palette was used to change the digital ink color.

Shared Design Space also allows continuous individual document orientation among multiple participants with arbitrary viewing angles. For further interaction (e.g. changing the ink color, the brush size or the ink intensity), we used different tangible tools. For example, a real paint box was used to allow people to change ink color (see Fig. 9). The interaction with these tangible items was also performed with the digital pen. Selecting a color, for example, can be done by simply touching the pen tip to a physical color object. A visual feedback area attached to each workspace changes color when a successful action is performed.

The current setup consists of four projectors mounted above the interactive table. There are no special sensors integrated into the table. For tracking, we simply use Anoto's digital pen technology [7]. A unique pattern paper with tiny dots is placed on the table's surface. On top, we put a transparent Plexiglas cover to protect the paper. The Anoto pens use an embedded infrared camera to track the tiny dots of the paper. Instead of using a normal pen tip, we used a stylus tip that does not leave a mark on the Plexiglas. The Shared Design Space can identify simultaneous pen-touches. Whenever the pen touches the table's surface, the system can identify the ID of the pen and the action of the users they want to perform. There is no limit to how many people interact simultaneously. During our installation at the iSpace exhibition of the Singapore Science Center, we observed that a lot of participants also expected to be able to interact with the fingers directly once they see an interactive display.

VI. CONCLUSION

BlogWall is a forum for the public to express their artistic capabilities using their mobile phones. The most notable feature of the system is its ability to create poetry. The poetry generation can be considered as a form of poetry mixing which can produce unexpected and surprising results. The main purpose of the MediaMe is to show bidirectional relationship between people and the media. It has been extended to create a 3D browser to provide the user a novel experience in browsing video content. MediaME and 3D browser can also be considered as a combination of creativity, art, and digital entertainment as well as an extension of personal media broadcasting.

ACKNOWLEDGEMENT

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