Mixed Reality Entertainment and Art

Adrian David Cheok, Michael Haller, Owen Noel Newton Fernando, and Janaka Prasad Wijesena

***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. We have developed few systems, including BlogWall, MediaMe, and Shared Design Space to provide such interactions between humans and computer entertainment.**

"BlogWall" is an extension of the existing text messaging to a new level of self-expression and public communication, combining visual art and poetry. "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. Finally, "Shared Design Space" is a collaborative sketching experience based on an interactive table setup.

***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 the innovative entertainment. 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 combination of art, culture, and technology.

II. RELATED RESEARCH

Social and physical interactions are the new frontier in entertainment. Today we build countless applications that provide entertainment to the masses but only limited number of them actually combines media art and culture to enrich user experience. It is essential that we build applications to fill the vast vacuum inside the interaction process. Following are some of the research work carried out combining media art, social, cultural and physical interaction.

One of the pioneering works in cultural computing was ZENetic computer [26]. It is an interface that evokes self-awakening through important aspects of Zen Buddhist culture. It tries to offer users a chance to engage and understand

Maniscript Received on October 20, 2007.
Adrian David Cheok,…….. ..adriancheok@mixedrealitylab.org
Michael Haller,…….…… ..michael.haller@fh-hagenberg.at
Owe Noel Newton Fernando,…….newtonfernando@mixedrealitylab.org
Janaka Prasad Wijesena…… janaka@mixedrealitylab.org

Buddhist principles of ‘recreation’ of the self. With stories portrayed in ink, haiku and kimono, the ZENetic conveys the rich allegorical interactive characteristic of Eastern philosophy. “i.plot" [27] is a system that discovers hidden connections between unrelated words by tracing possible paths through a database, traversing many two-word connections built from content based on publicly available resources. The “i.plot” uses a set of thought forms gathered from Japanese students, the WordNet database of grammatical structure, and the EAT database of psychological stimulus-response word pairs to produce an interesting and stimulating literary context.

The cultural computing project ALICE [21] is an interactive, entertaining experience inspired from ‘Alice in Wonderland’ [9]. In the scope of this project interactive adventures are experiences provided by an Augmented Reality (AR) environment based on selected parts from Lewis Carroll's book ‘Alice's Adventures in Wonderland’. The user assumes the role of Alice and explores this interactive narrative. The project uses AR as a new medium for edutainment and entertainment as a particular carrier for cultural transformations.

III. BLOGWALL

SMS or short message service is immensely popular among mobile phone users today [14]. It has been found that in the Philippines the average user sent 2,300 messages in year 2003 [3], which are a testimony to the immense popularity and the escalation of text messaging. But it is primarily used for peer-to-peer communication.

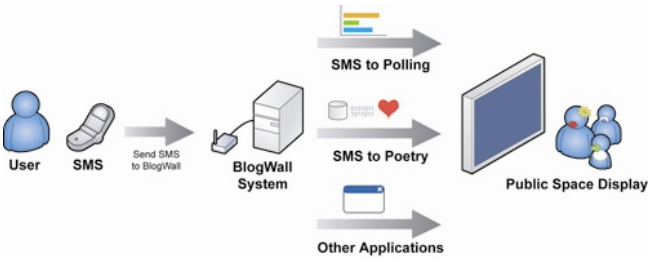

Fig. 1. Concept design of BlogWall

2.1 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 [10]. 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.

2.2 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.

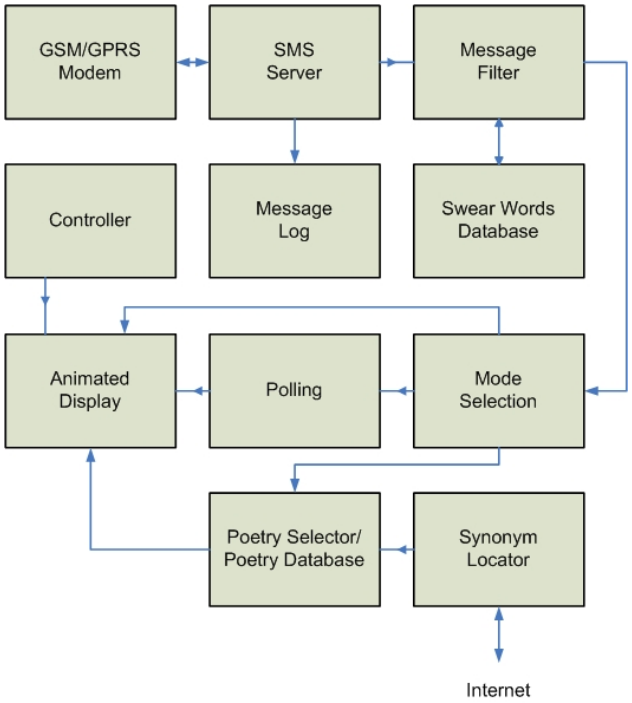

Fig. 2. System overview

Several modes of BlogWall are available which can activate to the requirements of the user. Fig. 2 shows an overview of the system. 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. Keyword recognition mode in the application facilitates to trigger an internal function based on contents of the SMS. In the current version the triggering word get replaced with an image. In the poetry mode a poem will be created with the means of the user SMS.

2.3 Poetry Generation

The longest words in the SMS are selected to locate synonyms from the Internet (currently by using the “Free

dictionary website" [12]). The synonyms are used to rank poems and poetry lines in an internal database. The database consists of lines of poetry and keywords related to each line and poem. When the system administrator adds a new poem to the system all the keywords related to the poem and poem lines get generated and stored in separate table in the database.

Fig. 3. BlogWall at Singapore Science Centre

The ranking of the poems is done based on the number of synonyms found in each poem. The poem that contains most number of synonyms gets the highest poem ranking. In the selected poem, the line that contains the highest number of synonyms gets the highest line ranking. Based on ranking most suitable poetry line will be selected to display. The extension of this poetry mode is the creation of cultural poetry. The system uses databases containing Korean, Chinese, and Japanese poetry and their English meaning. Synonyms found from the Internet are used to select poetry from these databases. The original text message, poetry in original language and its English meaning are displayed on the screen. The poetry generation system select poetry by a simple mechanism and the generated poetry may not fall into the same context of the users SMS. To counter these shortcomings more advance poetry generation system was developed.

2.4 Advance 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 [15]; two examples that exist in publication. These are in turn similar to ELIZA [29] 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.

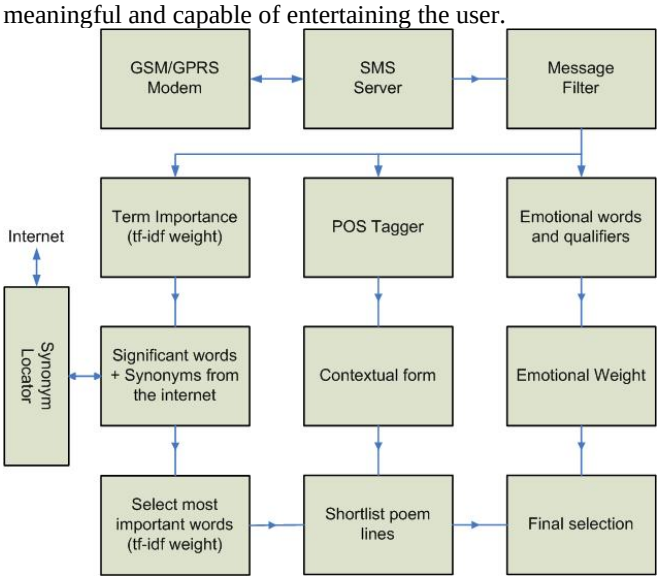

Fig. 4. Advance poetry generation

The advanced poetry generation process in the BlogWall consists of several additional stages. The system uses three different criteria to shortlist discrete sets of poem lines. The schematic in Fig. 4 illustrates the process. Three separate analyses are performed on each incoming message.

2.4.1 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. 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.

2.4.2 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 [28], 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.

2.4.3 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 [23]. 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.

2.4.4 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.

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. 5 shows the concept view of the MediaMe system.

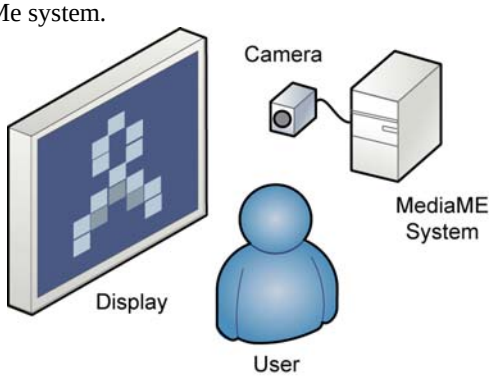

Fig. 5. MediaME concept view

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.

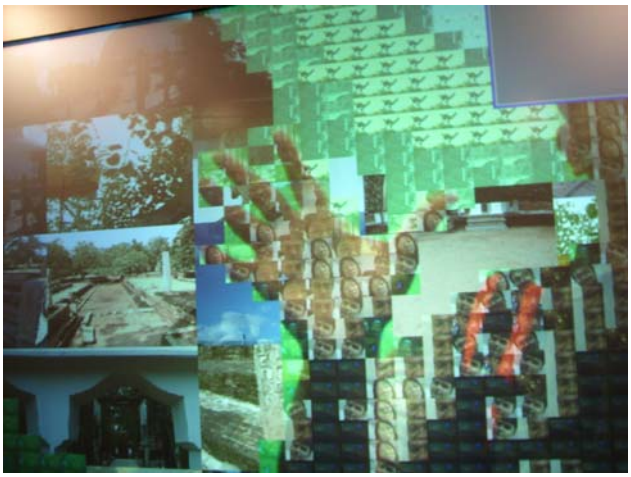

Fig. 6. MediaME at Singapore Science Centre

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.

3.1 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 [13], YouTube [31], 3WNews [30], 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 [25] provide very innovative and easy to use interfaces. Photo Tourism [24] 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 [11] 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.

3.2 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.

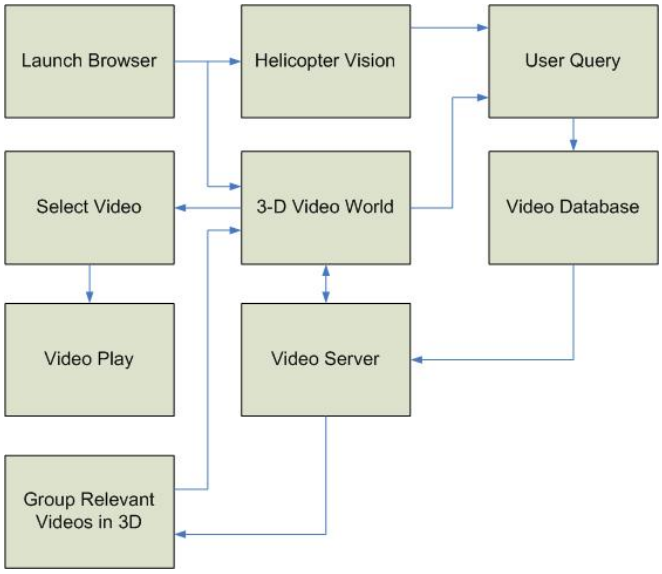

Fig. 7. 3-D video browser working model

Fig. 7 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. Furthermore the world of videos is generated through rendering the videos from a server. In order to render the videos in the browser we utilize the Win32 API architecture system. In this system we utilize memory pointers to open the video streams for relevant videos and then using the pointer render the video frame-wise. 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. Since the automatic tagging of videos based on its contents is a complex process and it is beyond the scope of this research, the application relies on human intervention. These tag information is stored in a database and is used in user searches.

3.3 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. Each word can be considered as a flower. 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 8.

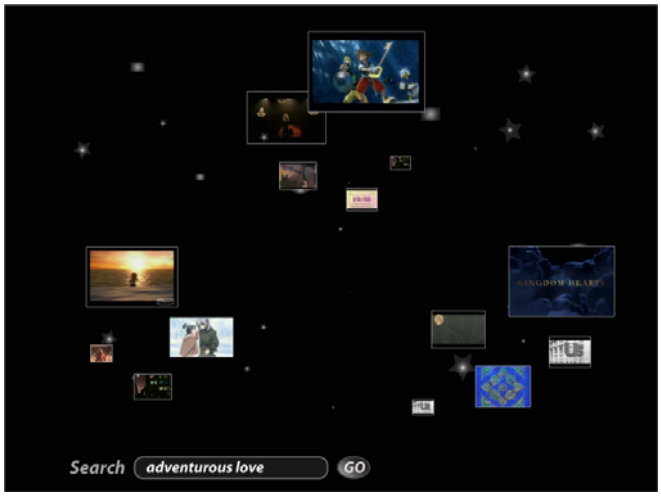

Fig. 8. 3-D video browser

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. 9). These annotations remain on the widgets as they get moved on the table surface for further discussion.

Fig. 9. 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 [22].

Fig. 10. 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. 10). 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

BlogWall, MediaMe, and Shared Design Space are funded by Singapore Science Center. All of these projects are installed in the iSpace at Singapore Science center to allow visitors to obtain novel experiences in entertainment and social communication.

REFERENCES

[1] 3D Picture Browser [Online]. http://www.download.com/3D-Picture-Browser/3000-2193_4-10601647.html?tag=pub

[2] Ananny, M., Strohecker, C., Biddick, K. Shifting Scales on Common Ground: Developing Personal Expressions and Public Opinions. In International Journal of Continuing Engineering Education and Life Long Learning (2004) 484-505.

[3] Atieh dadeh paradaz: Sms popularity. [Online]. http://www.adpdigital.net/content/en/resources/sms/popularity.aspx.

[4] Ballagas, R., Rohs, M., and Sheridan, J. G. 2005. Sweep and point and shoot: phonecam-based interactions for large public displays. In CHI '05 Extended Abstracts on Human Factors in Computing Systems (Portland, OR, USA, April 02 - 07, 2005). CHI '05. ACM Press, New York, NY, 1200-1203.

[5] Bederson, B. B. 2001. PhotoMesa: a zoomable image browser using quantum treemaps and bubblemaps. In Proceedings of the 14th Annual ACM Symposium on User interface Software and Technology (Orlando, Florida, November 11 - 14, 2001). UIST '01. ACM, New York, NY, 71-80.

[6] Blinkenlights art installation http://www.blinkenlights.de

[7] Brandl, P., Haller, M., Hurnaus, M., Lugmayr, V., Oberngruber, J., Oster, C., Schafleitner, C., Billinghurst, M., 2007. An Adaptable Rear-Projection Screen Using Digital Pens And Hand Gestures, in IEEE ICAT 2007, pp. 49-54, November 2007.

[8] Caputo, L, Garner, R., Nathan, P. FRED, Milton and Barry: the evolution of intelligent agents for the Web. In *Advances in intelligent systems* (1997) 400-407

[9] Carroll L. (1865). Alice's adventures in Wonderland. Macmillan, London.

[10] Cheverst, K., Dix, A., Fitton, D., Kray, Ch., Rouncefield, M., Saslis-Lagoudakis, G., Sheridan, J.: Exploring Mobile Phone Interaction with Situated Displays. PERMID 2005: 43-47.

[11] Chiu, P., Girgensohn, A., Lertsithichai, S., Polak, W., and Shipman, F. 2005. MediaMetro: browsing multimedia document collections with a 3D city metaphor. In Proceedings of the 13th Annual ACM international Conference on Multimedia (Hilton, Singapore, November 06 - 11, 2005). MULTIMEDIA '05. ACM, New York, NY, 213-214.

[12] Free dictionary website. [Online]. http://www.thefreedictionary.com.

[13] Google Videos website. [Online]. http://video.google.com/.

[14] Grinter, R.E. and Eldridge, M., y do tngrs luv 2 txt msg? In Proceedings of Seventh European Conference on Computer-Supported Cooperative Work ECSCW '01, (Bonn, Germany, 2001), Dordrecht, Netherlands: Kluwer Academic Publishers, 219-238.

[15] Hartman, Ch., . *Virtual Muse: Experiments in Computer Poetry*. Wesleyan University Press, 1996.

[16] Manurung, H., Ritchie, G., and Thompson, H.. Towards a computational model of poetry generation. In *Informatics Research Report*, Edinburgh, 2000.

[17] Martin, K., Penn, A., and Gavin, L. 2006. Engaging with a situated display via picture messaging. In CHI '06 Extended Abstracts on Human Factors in Computing Systems (Montréal, Québec, Canada, April 22 - 27, 2006). CHI '06. ACM Press, New York, NY, 1079-1084.

[18] Milgram, P., Kishino, F., A taxonomy of mixed reality visual display, IEICE Transaction on Information and Systems, vol. E77-D, no. 12, pages 73–87, December 1994.

[19] PicLens [Online]. http://www.piclens.com/site/firefox/win/

[20] Pua, K. M. Gauch, S. and Gauch, J. VIDSEEK: Dynamic Multi-dimensional Browsing of Video Archives, ACM SIGIR '99 Workshop on Multimedia Indexing and Retrieval, Berkeley, CA, August 1999, 1-17.

[21] Rauterberg M., Usability in the future –explicit and implicit effects in cultural computing. In: AM. Heinecke, H. Paul (Eds.): Mensch & Computer 2006: Mensch und Computer im StrukturWandel (pp. 29-36). München, Oldenbourg Verlag.

[22] Rekimoto, J.: Pick-and-drop: a direct manipulation technique for multiple computer environments. In: UIST '97: Proceedings of the 10th annual ACM Symposium on User interface software and technology, New York, NY, USA, ACM Press (1997) 31–39.

[23] Russell, J., A Circumplex Model of Affect, Journal of Personality & Social Psychology, Vol. 39 (1-sup-6), Dec. 1980, 1161-1178.

[24] Snavely, N., Seitz, S. M., and Szeliski, R. 2006. Photo tourism: exploring photo collections in 3D. In ACM SIGGRAPH 2006 Papers (Boston, Massachusetts, July 30 - August 03, 2006). SIGGRAPH '06. ACM Press, New York, NY, 835-846.

[25] TiltViewer [Online]. http://www.airtightinteractive.com/news/?p=92

[26] Tosa, N., Matsuoka, S., Miyazaki, K., Interactive storytelling system using behavior-based non-verbal information: ZENetic computer. In Proceedings of the Eleventh ACM international Conference on Multimedia (Berkeley, CA, USA, November 02 - 08, 2003). MULTIMEDIA '03. ACM Press, New York, NY, 466-467, 2003.

[27] Tosa, N., Torroella, A. R. , Ellis, B., Matsuoka, S., and Nakatsu, R.. Computing inspiration: i.plot. In SIGGRAPH '05: ACM SIGGRAPH

2005 Emerging technologies, page 3, New York, NY, USA, 2005. ACM Press.

[28] Tsuruoka Y., and Tsujii, J. Bidirectional Inference with the Easiest-First Strategy for Tagging Sequence Data. In *Proceedings of HLT/EMNLP*, 2005, pp. 467-474.

[29] Weizenbaum, J., Eliza – a computer program for the study of natural language communication between man and machine. *Communications of the ACM*, 9(1):36-45, 1966.

[30] Yang, J. and Hauptmann, A. G. 2006. 3WNews: who, where, and when in news video. In Proceedings of the 14th Annual ACM international Conference on Multimedia (Santa Barbara, CA, USA, October 23 - 27, 2006). MULTIMEDIA '06. ACM Press, New York, NY, 503-504.

[31] Youtube Videos website. [Online]. http://www.youtube.com/.

Adrian David Cheok is Director of the Mixed Reality Lab, National University of Singapore. He is Associate Professor in the Department of Electrical and Computer Engineering. He was born and raised in Adelaide Australia, graduated from the University of Adelaide with a Bachelor of Engineering (Electrical and Electronic) with First Class Honors in 1992 and an Engineering PhD in 1998. He has previously worked in real-time systems, soft computing, and embedded computing in Mitsubishi Electric Research Labs (Osaka, Japan). He has been working on research covering mixed reality, human-computer interaction, wearable computers and smart spaces, fuzzy systems, embedded systems, power electronics, and multi-modal recognition. He has successfully obtained funding for externally funded projects in the area of wearable computers and mixed reality from Nike, National Oilwell Varco, Defense Science Technology Agency, Ministry of Communications and Arts, National Arts Council, Singapore Science Center, Hougang Primary School. The research output has included numerous high quality academic journal papers, research prototype deliverables numerous demonstrations including to the President and Deputy Prime Minister of Singapore, broadcast television worldwide broadcasts on his research (such as CNN/CNBC/Discovery/National Geographic), and international invited new media exhibits such as in Ars Electronica and Wired Nextfest.

Michael Haller is an associate professor at the department of Digital Media of the Upper Austria University of Applied Sciences (Hagenberg, Austria) and responsible for computer graphics, multimedia programming, and augmented reality. He received Dipl.-Ing. (1997), Dr. techn. (2001) and Habilitation (2007) degrees from Johannes Kepler University of Linz. He has produced technical publications and his work has been demonstrated at a wide variety of conferences. Furthermore, he is active in several research areas, including interactive computer graphics, augmented and virtual reality, and human computer interfaces. His current focus is on innovative interaction techniques and interfaces for next generation working environments. In 2004, he received the Erwin Schroedinger fellowship award presented by the Austrian Science Fund for his stay at the HITLabNZ, University of Canterbury (New Zealand), and the IMSC, University of Southern California (USA).

Owen Noel Newton Fernando is a Research Fellow in the Mixed Reality Lab. at the National University of Singapore. He received his B.Sc. in Computer Science from the University of Colombo, Sri Lanka, and M.Sc. & Ph.D. in Computer Science and Engineering from the University of Aizu, Japan. He has previously worked at the Peoples Bank (leading government bank in Sri Lanaka) IT department as a Systems Analyst. His research interests are mobile computing, entertainment computing, human-computer interaction, mixed & virtual reality, ambient information, narrowcasting commands with spatial sound, and conference selection functions for multipresence. He was awarded the Distinguish Laksakura fellowship (Herath Foundation) in 2001, a Japanese Government (Gakushu-shoreihi: MEXT) Scholarship in 2002, a SAISUA Scholarship for outstanding scholastic performance in 2003, and a Japanese Government (Monbukagakusho: MEXT) Scholarship in 2004. Fernando is the author or coauthor of five Journals and over twenty conference publications.

Janaka Prasad Wijesena is a Research Fellow in the Mixed Reality Lab at the National University of Singapore. He received his B.Sc. and M.Sc. in Computer Science & Engineering from the University of Moratuwa, Sri Lanka. He has a wide range of industry experience. Previously he worked at the Suntel Lanka (Pvt.) Ltd. as an Oracle systems administrator, Lanka On-Line (Pvt.) Ltd. as a software engineer. He also worked at Microimage (Pvt.) Ltd. as a mobile application developer and at VA Lanka (Pvt.) Ltd. as a senior software engineer. In the mixed reality lab he has been working on exciting projects like MediaME, BlogWall, Metazoa Ludens and 3D Browser. His research interests are computer vision, human-computer interaction, mixed & virtual reality, computer graphics, MMORPG (massively multiplayer online role-playing game) and mobile entertainment.