An Adaptive and Interactive Storytelling System for Mobile Augmented Reality Ambiance (AISTMAR)

Dr. M. Durairaj[1]
School of Computer Science, Engineering and Applications, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

P.Sagaya Aurelia[2]
1,2 School of Computer Science, Engineering and Applications, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

***Abstract*:**Storytelling being the core part of human experience which can be either embedded or emergent is more effective when it is used in an immersive environment. Interactive storytelling closes the gap between data and action.Mobile augmented reality and interactive storytelling go along with each other because when they are combined an effective, adaptive and exciting learning environment comes into form. In this paper, an adaptive and interactive storytelling system for mobile augmented reality environment is proposed which consists of story manager, story planning engine, story suggestion engine and story generation system and thereby followed by story validation module and finally the AR view of the story is displayed. Marker manager performs the task of marker assignment and integrating marker with story content. Constructive features such as system usabilityscore,pretest and posttest and effectiveness of the methodology was tested through the conducted user study. The results and findings proves that adaptive and interactive storytelling system based on mobile augmented reality system is more effective in terms of user experience and enhanced learnability factor.

Keyword-*Augmented Reality; storytelling; Human Computer Interaction, Immersive environment; Learnability, usability; interactive intelligence; marker recognition; Mixed Reality; Mobile Augmented Reality.*

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I. INTRODUCTION

Mobile augmented reality system is defined as the real-world object and virtual object aligned with each other as shown in figure 1. It is executed in real time mobile mode. It is a combination of real and virtuality.

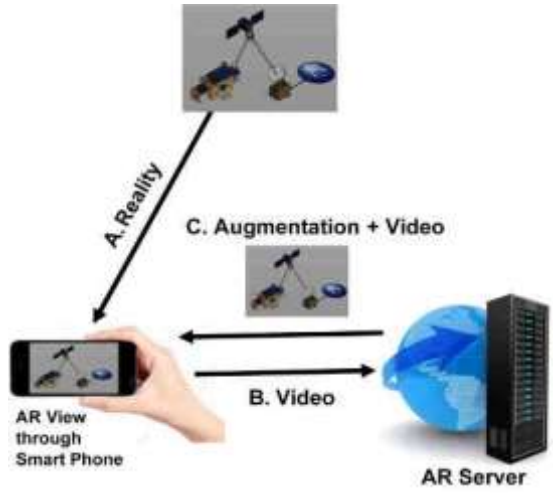


Figure 1. MAR workflow [1]

Interactive storytelling closes the gap between data and action. The combination of immersive and interactive storytelling mode is one of the latest enhancements in the technological world. It has broken all the barriers of lack of real time experience due to mobile augmented reality since it provides the real time as well as the virtual world experience. Whenever the narratives are interactive it reaches all type of users. Only in interactive environment the user's input and behavior, flow of events are taken considered and responded well. Especially when complex structured stories are created the effective use of data plays a vital role. All levels of storytelling system should be accessible to the user when data points are established.

Multisensory behavior of mobile augmented reality is one the additional features which makes the interactive storytelling system more approachable whereas, just the audio-visual simulation is a major limitation of electronic story telling system. Mobile augmented reality technology has a great scope and higher reach for innovative endeavors in storytelling.

The remainder of the article is organized as follows: we start in Section 2 with the state of art. In Section 3, we discuss the aspects of AISTMAR: the working principle and the algorithm. This is followed in Section 4 with the results of experiments in three different storytelling environments and we finish in Section 5 with conclusions anddiscussion of future work.

II. STATE OF ART:

[8] proposes an IS render engine followed by IS controller which shows the suitable subtitle of the game. A sequent that models the situation of the game is stored in linear logic model. Automatic reasoning of the sequent is also given here. The whole work deals with validating the IS model based on Linear Logic sequent(an automatic proof graph). [9] takes general-purpose planning algorithms for narrative aspects. Story is planned automatically. Therefore, the planning is based on Boolean expression that is a simple "true or false

relation". [10] L.M. Barros and S.R. Musse goes beyond Boolean reasoning which can be beneficial to system. Improvements are expected in future planning algorithms. Specifically, learning of mutual exclusion relations and optional events allows coherent stories to be generated from a domain model capturing different possible, non-contradictory story trajectories. The story generation algorithm suggested and report on results of a large-scale evaluation of thestories generated by the system, which indicated performance on par with non-expert human storytellersform the solution to the original problem. [11] created a virtual storyteller, whichcan be used to study the expression and perception of emotionsin real-time immersive virtual environments. An approach for creating a virtual storyteller bymorphing body and facial emotional states (ESs) based onpreviously annotated texts. To verify the realism of the presentationof the storyteller a user study was performed, inwhich virtual storyteller to an animationof an actor is compared with telling a fairy tale.[12] comes forth with a research proto-type which generates *satellite* sentences (which moderate pacingand reestablish context) which are inserted into an otherwise hand-authored interactive story. Generation is accomplished with an adaptive set of grammars configured based on the currentnarrative context. [13] CHESS (Cultural Heritage Experiences through Socio-personal interactions and Storytelling) has developed a comprehensive evaluation framework, which can be generalized for use with novel digital cultural storytelling experiences at large. The effect of particular technological choices (e.g., adaptivity, transparent "user modelling" methods via social networks, the mobile Augmented Reality features, etc.) was examined. [14]presents a new design formalism, Interactive Behavior Trees (IBT's),which decouples the monitoring of user input, the narrative, andhow the user may influence the story outcome. We introduce automationtools for IBT's, to help the author detect and automaticallyresolve inconsistencies in the authored narrative, or conflicting userinteractions that may hinder story progression. [15] highlights the importance of Systematic Story Modeling, which is achievablethrough the collaborative efforts of Technical Author and Story Author. The approach tostory modeling is detailed by elaborating three basic models such as defined, evolvingand *epicentric* stories. [16]The overall aim of the European research project 80Days situated inthe field of Technology-enhanced Learning is to combine adaptive learning,Storytelling and gaming technology in order to build intelligent, adaptive andexciting learning environments in the form of Storytelling-based digitaleducational games (DEGs). [18] In this a papera storytelling environment is presented consisting of an audioreplay engine and a tactile user interface based on a sensornetwork. The implemented user interface has the form of a farmmade out of cloth with stuffed animals as actors. Story Toy is an environment with multiple characters that cantell a story. [19] This approach to narrative generation is fully implemented in an interactive narrativebased on the "Merchant of Venice." we have followed a popular approach in IS in which the modelingof a baseline classical plot is a first step towards interactive narrative. [20] This thesis proposes a new approach to video-based interactive narratives that uses real-time video compositing techniques to dynamically create video sequences representing the story events – rather than proposing a simple method that merely assembles prerecorded scenes. This approach allows the generation of more diversified stories and reduces the production costs. However, it requires the development of fast and intelligent algorithms, capable of applying cinematography techniques to create cinematic visual representations for the story events in real-time.

III. An adaptive and interactive story telling system for mobile augmented reality ambiance (AISTMAR):

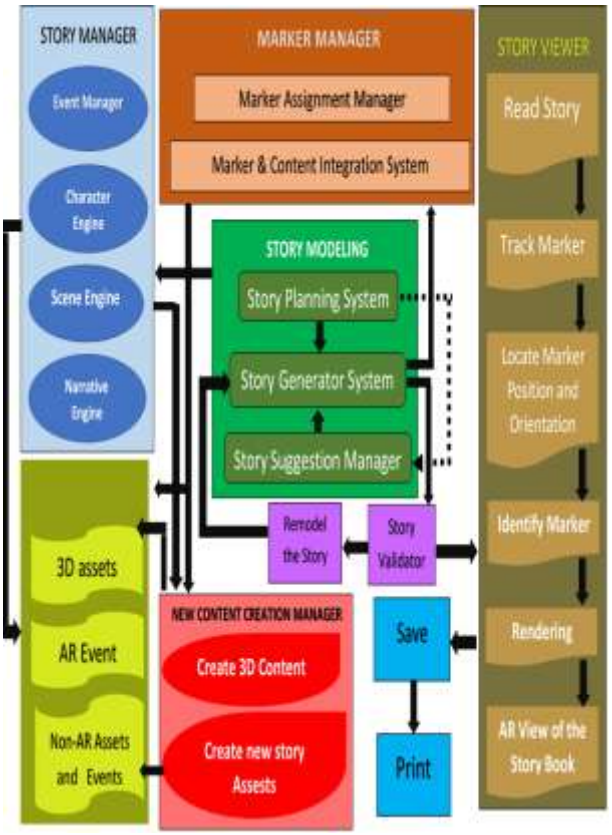


Fig 2: AISTMAR block diagram

The block diagram of adaptive and interactive storytelling system in mobile augmented reality based environment is shown in figure 2. It is divided modules such as story manager, context database, marker manager, story modelling phase, new content creation manager, story viewer. The story manager handles and maintenances all story related contents such as character, scene, narratives and events. When the user creates a new story and frames events they are redirected to this story manager and events are frames and connected with each other. While designing the story the assets and contents are retrieved

from the context database. When the content wanted by the user doesn't exists in the context database then it is redirected to the new content creation manager. The new content manager performs functions like creation of new story assets of AR and non-AR assets. Contents of different formats such as image, audio, video, text are stored assets.Many content creation interfaces are connected in order to provide the user flexibility to create content of their own. Once the newcontents are created then it is saved to the database which can be accessed the new time by the user. The context database module maintains contents such as 3D assets, AR events and non-AR events. The database maintains the static information about story as well as the dynamic information about the development of the story overtime period. As the system is based on marker based mobile augmented reality the marker manager is responsible for the marker assignment and the integration of the marker to the specific relevant content from either the database or new content creation manager. Three functionalities such as story planning manager, story editor or generator and story suggestion manager are done in story modeling phase. Story planner provides the user an initial preparation to set a route map for the story. After planning the story, the user has the option of chosen story suggestion system or enter directly story editor. If the story suggestion option is used various story plotting algorithm are connected to the system based on which the user has the option to either modify or delete. Finally, story editor is where the story is generated and forwarded to story validator for validation. Story validator validates if all characters are used and if all scenes are connected with the each other. The continuity of the events is also validated here. If errors are found then it is redirected to the remodeling phase were again the story is edited else the story viewer mode is enabled. The story viewer initially read the story track the marker locates the marker positions and orientation and then identifies the marker. Once the marker is identified then the assets are rendered and the complete AR view of the storybook is generated. The story is saved and printed.

IV. ALGORITHM OF AISTMAR

Step 1: start
Step 2: if (user=valid) go to step 4
Step 3: else quit
Step 4: start function STY_PLNR
Step 5: initialize CHRT=0, NARR=0, SCE=0
Step 6: if (option use existing character=Y) go to function CON_DATABASE
Step 7: else go to CREATE_CHRT
Step 8: if (option use existing narratives=Y) go to function CON_DATABASE
Step 9: else go to CREAT_NARR
Step 10: if (option use existing scene=Y) go to function CON_DATABASE
Step 11: else go to CREATE_SCE
Step 12: make EVNT
Step 13: if (option more events =Y) go to step 6
Step 14: save events in CONTEXT_DATABASE
Step 15: if (option STY_SUGGEST = Y) go to function STORY_SUGG
Step 16: else Start function STY_GENTR
Step 17: if (option retrieve_ story planning =Y) enter the file name
Step 18: open the file
Step 19: go to function STORY_VALI
Step 20: else
Step 21: input the no of events n
Step 22: for (i=0;i<n;i++)
Step 23: enter CHRT, NARR and SCE
Step 24: make EVNT
Step 25: if (option AR view _for CHRT or NARR or SCE=Y) then go to function MARKER_MNGR
Step 26: else go to step 31
Step 27: start function MARKER_MNGR
Step 28: assign markers for CHRT or NARR or SCE
Step 28: if (option retrieve 3Dcont_database=Y) go to function CON_DATABASE
Step 29: else CREATE_3D_CONTENT
Step 30: Save in CON_DATABASE
Step 31:loop until no of events N =0
Step 32: go to function STORY_VALI

FUNCTION STORY_SUGG

initialize the system
view example mode=T
If (option need_more_ suggestion =Y)
go to inbuild_ plotter_ graph _algorithm
If (option modification =Y) modify C or N or S
If (option delete = Y) delete C or N or S
Else go to function STY_GNTR

FUNCTION STY_ MNGR

Design NEW_CHAR
Design NEW_NARR
Design NEW_SCE
Make NEW_EVNT

FUNCTION STY_VIEWER

Read story
Track marker
Locate marker position and orientation
Identify marker

Get the assigned rendering 3D augmented content from context DB

complete view of AR story book

If(option STY_VIEW =ok) then

Save

Print

Exit

Else go to function STY_REMDL

FUNCTION STY_REMDL

Enter option M for modify and D for delete

If (option M=Y) then modify CHAR or NARR or SCE or 3D_CONT

If(option D=Y) then delete CHAR or NARR or SCE or 3D_CONT

Go to function STY_VALI

FUNCTION CONT_DATABASE

Retrieve or select CHRT

Select NARR

Select SCEN

Select from saved EVNTS

Select from stories saved from function STY_PLANNER

End function

FUNCTION STORY VALIDATION

If (option ALL_CHRT_USED=Y)

If (option ALL_SCE_COMPELET=Y)

If(option ALL_CHRT && NARR CONN=Y)

If (option EVNT_COMP=Y)

Go to function STY_VIEWER

Else go to function STY_GENTR

V. RESULTS AND DISCUSSION

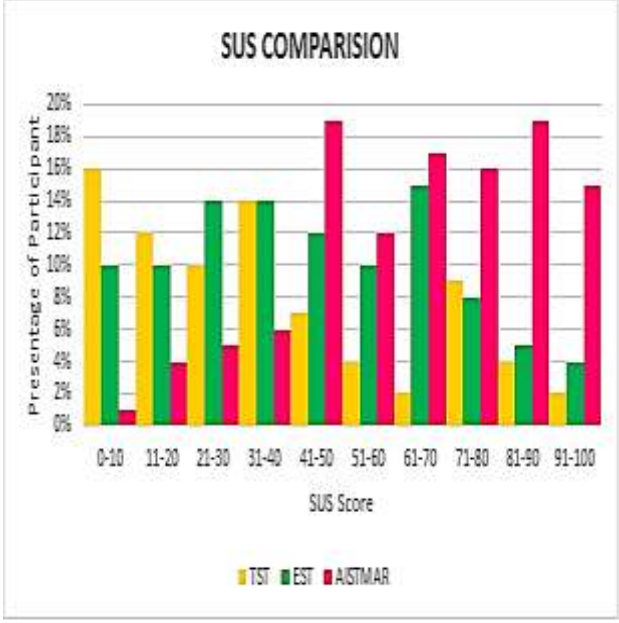


Figure 3: Comparison chart of SUS score

A comparative study between traditional storytelling, e-storytelling and adaptive and interactive storytelling system using mobile augmented reality is shown in figure 3. System usability score test was conducted for students of mathematics and computer science department from faculty of education, Bani Walid, Libya.Total number of 50 students participated in the study. A graph showing the system usability score versus percentage of participants is shown in figure 3.Initially the traditional mode of storytelling was very successful because the users were used to the system. Later when the augmented reality based storytelling system was more attractive, comfortable, the SUS score rapidly increased for AISTMAR. Even though e- storytelling method used instructiveness and all information and communication technology resources lack of immersive feeling made the user to opt for augmented reality based storytelling system.

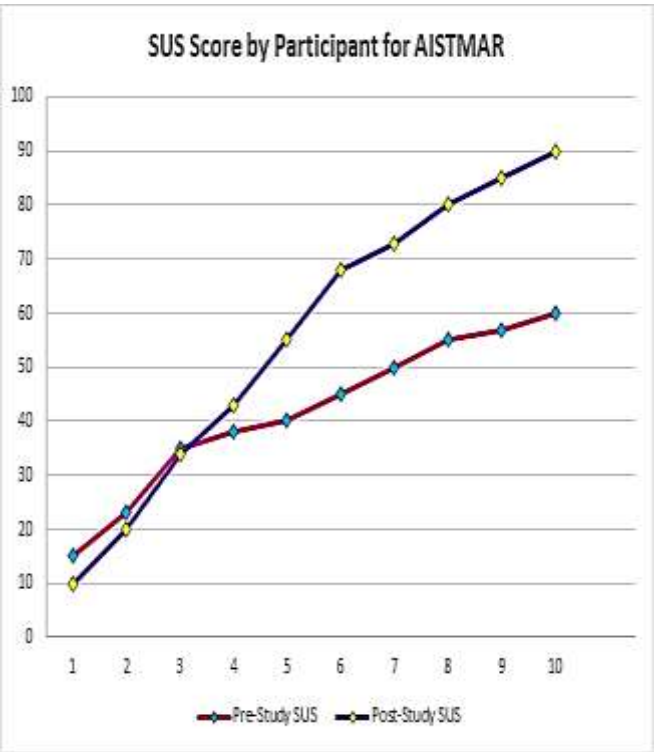
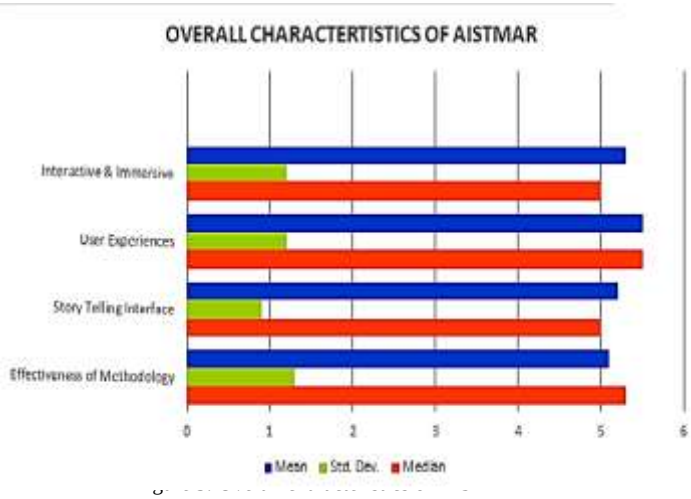


Figure 4: SUS score by participant for AISTMAR

Figure 4shows the pretest and posttest result of the conducted research. Pretest result shows that the initial level of all users were same. Students from department of computer science and mathematics has the same level of prior storytelling knowledge. After using the system, posttest based on system usability score was conducted. Various factors like creativity, effectiveness and learnability factors were examined in posttest. After a certain intermediate point (the point where student's understandability towards the new system)the posttest result proved the effectiveness of AISTMAR.



The overall effectiveness of AISTMAR was evaluated as shown in figure 5. Mean, standard deviation and median of our system was measured based on various criteria's such as interactives, immersive, storytelling resource with respect of knowledge objective and the overall effectiveness of the methodology was measured and proved as shown in figure 5.

CONCLUSION AND FUTURE WORK

A boom in storytelling industry has started due to enhanced visualization technology. When mobile technology, augmented reality and interactive storytelling are combined it will reach wide range of users. The research conducted also proved that mobile augmented reality technology based adaptive and interactive way of storytelling was more effective and efficiency comparing to both the traditional way of storytelling and storytelling using electronic resources that is non-AR based storytelling system**.**

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