HYBRID RECIPROCATIVE MODEL FOR AUTHORING AND CONTENT EXPERIENCE IN MOBILE AUGMENTED REALITY AMBIANCE

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ABSTRACT

Mobile augmented reality is simply seen as a part of our regular life regardless of the scope and the field because of its pervasiveness. The real world with virtual data embedded in it is allowed in augmented reality. Especially mobile augmented reality has compelling, significance in the field of education.

In this paper, a hybrid reciprocative model for authoring and content experience inmixed reality ambiance is introduced. The learning model which provides the content experience is followed by the content creation phase consists of augmented content management system for authoring mode which deals with interactive multiple intelligence contents. An adaptive and interactive storytelling system for mobile augmented reality environment is appendedin authoring module which consists of story manager, story modeling 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.

The effectiveness of this novel hybrid model is examined and evaluated. The results and findings proves that our hybrid model for content experience and authoring forboth interactive storytelling and multiple intelligence content in mixed reality ambience is more effective, simpler, faster in terms of user experience and enhanced understandability.

Keywords: 4R, learnability, usability, Augmented Reality, Immersive environment, Mobile Augmented Reality, Mixed Reality, Human Computer Interaction, authoring tool, interactive intelligence, marker recognition, interactive storytelling, AR storybook

I. INTRODUCTION

The enhanced display of the real world is made possible through mobile augmented reality. The live view of the real-world environment with 3D models, GPS information, graphics and sound content augmented with the visual elements in the display. The high level of immersion in AR is incredible. The main feature of augmented reality is real time constructiveness.Classification of augmented reality is based on the five natural powers of human sense of sight, taste, hearing, touch and smell. Augmented reality can be classified as Visual augmented reality (Sight), Haptic augmented reality (Touch), Gustatory augmented reality (Taste), Olfactory augmented reality (Smell) and Audio augmented reality (Hearing).

The hybrid modelconsists of content experience phase and authoring based on multiple intelligence and adaptive and interactive storytelling for mobile augmented reality environment.

Firstly, mixed reality provides a wide scope of content experience for both the users as well as the designers. Mixed reality based active learning system provides a modified level of usability and learning because it is suitable for any environment, experience or situation.

Secondly, with reference to content creation, even though augmented content management faces challenges like content creation, distribution, access, retrieval and interaction it is overcome through various techniques and used widely across the world. The content creation provides different levels of control and functions between the real and the virtual objects.

Finally, adaptive and interactive storytelling which is developing very rapidly, 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.

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 HRMACE-MRA the working principle and the algorithm. This is followed in Section 4 with the results of experiment and discussion and we finish in Section 5 withconclusions and future work.

II. STATE OF THE ART

Considering the first 4R learning module, only a very minimum amount of work has been done on renaissance learning based content experience, in midst of the great influence and scope of usability especially learnability, in the field of educational mobile augmented reality. SMART education system proposed by Rubina Freitas, Pedro Campos [10] is integrated and adequate with the curriculum guideline followed national wide, which uses grade level concepts as the foundation. The study proved that a very high level of motivation was found among the children who used SMART system. Especially the below average students were very positive when they used the SMART system.

ZarwinaYusoff[11] suggested a model integration of mobile learning through augmented reality which also takes student's attention elements under consideration. Science and technology was taken as learning content in AF-LAR prototype. The validation method was done based on descriptive statistic. variability(V), Perceptual arousal (PA) and inquiry arousal (IA) were the derived elements of attention resulted via Keller's Motivation ARCS Model.

Sukhyun Lim, Junsuk Lee [12] proposed an e-learning based AR technology in which the interaction with the content was done through the learning activities led by the learners. An authoring tool, an interface learning view and an engine which runs the learning content where designed. The main feature of system was shapes and functions of an objects which is quite difficult to learn through English language was taken as the learning elements.

An inquiry based learning activities using augmented reality based mobile learning system was stated in Tosti H.C. Chiang [9]. Very high motivations based on confidence and all the other related dimensions were examined who used the AR based mobile learning approach rather than the traditional inquiry based mobile learning system. A mobile augmented reality education (MARE)framework was designed and developed by Egui Zhu [8] which served as an educational app in specific for health care. The rational use of antibiotics [8] was the Main context. All the above systems focused on AR learning without considering and measuring the learner's cognitive settings. [8] is suitable only for educational health care. Our suggested system measures the research, reflection, reasoning and renaissance based on the learner's cognitive behavior. e-performance, digital competence, Emotional quotient and intelligent quotient are taken into consideration.

Considering authoring which is the second module, Hector Martinez, Seppo Laukkanen, Jouni Mattila [13] proposes a flexible framework for content development. Authoring tool and common AR engine with more features are present in this platform. Every user, irrespective of their programming skills, can develop AR application and make to make use of the AR engine was set as the main goal. Maintenance field was the main targeted platform. [14] proposes a system where the user can create any pair of markers and virtual objects using the AR content manager and an AR viewer is also provided to view the augmented virtual object. MARB is composed of function managers such as AR Accessory Manager, AR content Manager, AR Viewer, Virtual Object Manager and the Target Manager. [13] presents some approaches to address challenges like standardization challenge, technological challenge and tool challenges. VE is not fully immersive with using 3D content, but 2D elements are also used. It is used to address the main issues ofVE by developing post-WIMP UIs. [14] proposes a system to identify the key process and concepts that presentation authors. The presentation authors can make use of high-level patterns in AR environment. [15] suggests a desktop authoring AR tool based on WYSIWYG interfaces. It uses an authoring method called 'immersive authoring' which uses tangible AR interaction technique. The development and execution environment are the same, whereas the authoring environment provides builds content and gives the users a complete experience. The teachers are allowed to add 3D objects and even animated objects in [16]. It also provides an additional advantage of adding narrative about the virtual resource. Multiple choice questions(MCQ) can also be incorporated. A large library of resources is already made available in web platform which can be used by the teacher and the students. A participatory design approach is suggested by [17] for creating an ARLO. It allows two modes of authoring that is creating and editing. ARLO can also be adjusted iteratively once the feedback is received from the students. The system design of [18] has features such as Yes/No, the question data can be reused, two mode of operations present authoring mode and view mode and finally a simple, complete GUI is used in the system[10] has the main disadvantage of using the system only for maintenance field, which is not suitable for beginners to MAR irrespective of the field. An open target group is expected. [11] has a limitation of a very slow target recognition because of more functionalities and only one target can be recognized at a time. [12] has a main limitation of restricted only to Virtual Environment, were the real-world environment are totally ignored. Even though [13] suggest AR authoring, but still it is limited to only AR presentation, where multiple intelligence content is not focused. One of the main drawback of [14] is it is suitable only for desktop environment, which has its own limitation such as portability and limited accessibility. Even though [15] has a lot of salient features but, it is limited only to few type of multiple intelligences but not all. [16] is suitable only for creating and editing mode

of authoring. When we are in need of other augmented content management system processes such as modifying, deleting and storing the suggested system will not able to respond to it. The work suggested by [17] is limited to only examination system which cannot be used beyond it.

Many works have been done related to storytelling and AR book creation. [19] 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). [20] 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". [21] 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 the stories generated by the system, which indicated performance on par with non-expert human storytellers form the solution to the original problem. [22] created a virtual storyteller, which can be used to study the expression and perception of emotions in real-time immersive virtual environments. An approach for creating a virtual storyteller by morphing body and facial emotional states (ESs) based on previously annotated texts. To verify the realism of the presentation of the storyteller a user study was performed, in which virtual storyteller to an animation of an actor is compared with telling a fairy tale. [23] comes forth with a research proto-type which generates satellite sentences (which moderate pacing and 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 current narrative context. [24] 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. [25] presents a new design formalism, Interactive Behavior Trees (IBT's), which decouples the monitoring of user input, the narrative, and how the user may influence the story outcome. We introduce automation tools for IBT's, to help the author detect and automatically resolve inconsistencies in the authored narrative, or conflicting user interactions that may hinder story progression. [26] highlights the importance of Systematic Story Modeling, which is achievable through the collaborative efforts of Technical Author and Story Author. The approach to story modeling is detailed by elaborating three basic models such as defined, evolving and epicentric stories. [27] The overall aim of the European research project 80Days situated in the field of Technology-enhanced Learning is to combine adaptive learning, Storytelling and gaming technology in order to build intelligent, adaptive and exciting learning environments in the form of Storytelling-based digital educational games (DEGs). [28] In this a paper a storytelling environment is presented consisting of an audio replay engine and a tactile user interface based on a sensor network. The implemented user interface has the form of a farm made out of cloth with stuffed animals as actors. Story Toy is an environment with multiple characters that can tell a story. [30] This approach to narrative generation is fully implemented in an interactive narrative based on the "Merchant of Venice." we have followed a popular

approach in IS in which the modeling of a baseline classical plot is a first step towards interactive narrative. [31] 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. HYBRID RECIPROCATIVE MODEL FOR AUTHORING AND CONTENT EXPERIENCE (HRMACE-MRA)
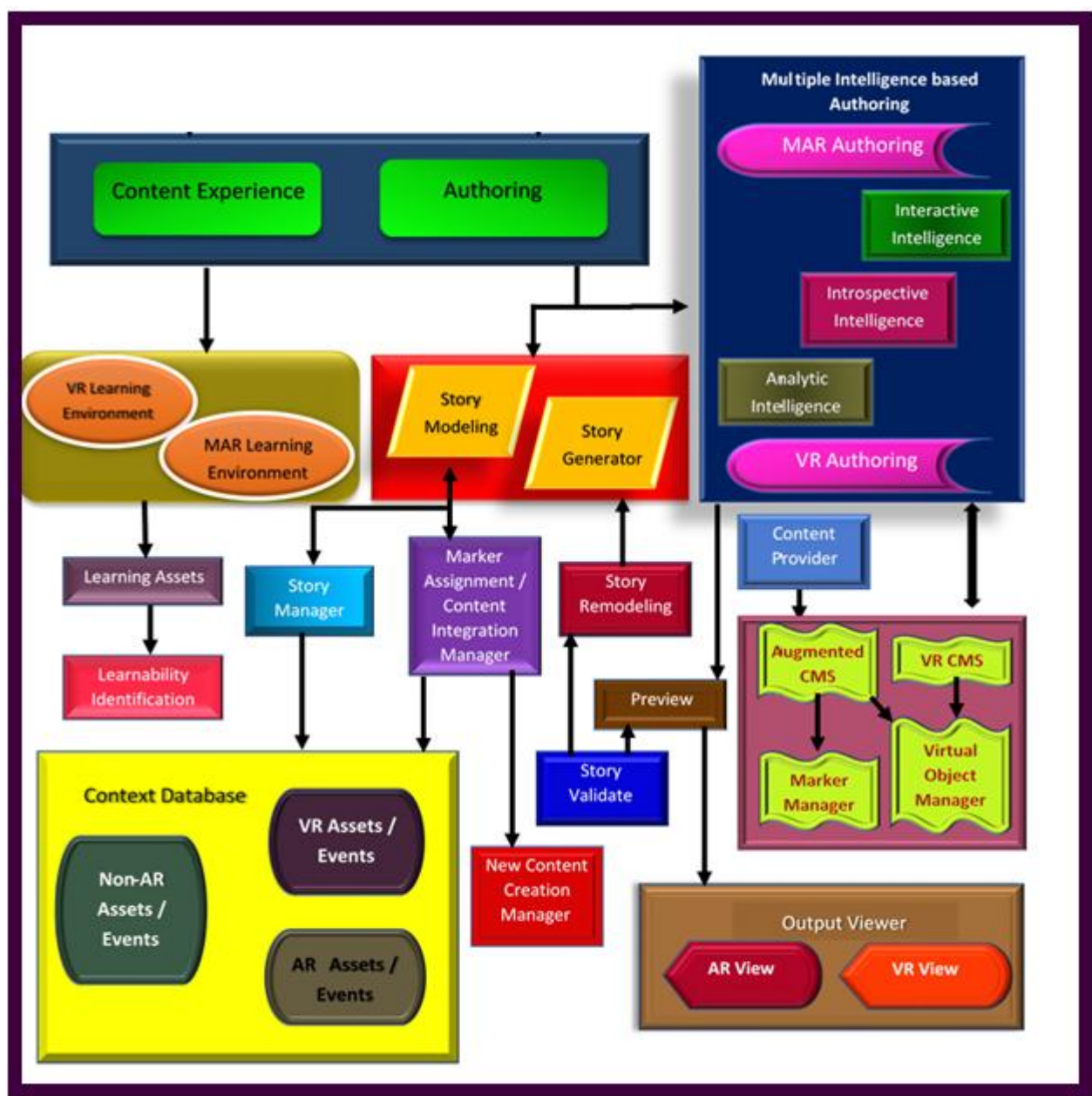

Figure 1: Block Diagram Of HRMACE-MRA

Figure 1 shows the block Diagram Of Hybrid And Reciprocative Model For Authoring And Content Experience In Mixed Reality Ambiance(HRMACE-MRA). It is basically divided into content experience module and authoring module.

a. The Content Experience Module (4R)

The content experience module is based on 4R learning theory which is the core concept and it lays a foundation for establishing learning environment, organizing study materials and devising learning activities. Our system foundation is on modified learning theories such as technology based education (TBE) and active learning which is well suitable for augmented reality based learning method.

The learnability factor is defined as follows

LIF = Res + Rea + Ref + Ren

Where

LIF= Learnability identification factor

Res=Research

Rea=Reasoning

Ref=Reflection and

Ren= Renaissance

The process of understanding results in research. The intelligent quotient(IQ) is evaluated in cognitive. Digital Competence also known as reasoning involves the critical use of information technology. It is assessed at different stages. Explore, express and exchangeare involved in reasoning phase. e-performance also known as reflection is implemented using learning strategies. Emotional quotient (EQ) is evaluated as cognitive factor. All the above three factors help to find the learnability of the learner. The Renaissance helps to motivate the student to increase the interest towards technology based learning. Learnability level faces a rapid growth because of this renaissance factor.

b. Authoring and Managing Multiple Intelligence Content

As far as content creation and delivery challenges are concern, based on the type of content, either imported content or homemade content or external content, selection of content, automatic creation of AR page and less control over the external source quality are the main issues to be addressed. Some more additional challenges to be addressed are visibility challenge, creation and authoring challenges and standardization challenge.

Mobile augmented reality authoring module is used to create the content and author AR pages. The marker(target) manager is used to manage all the markers. In our system, target manager performs various tasks related markers such as creation of a new marker, manage the markers, manipulate or modify the assigned markers, store the designed markers and delete the designed marker. Whenever the author is in need of creating or performing any tasks related to markers, this marker (target manger) takes the role.

Next, the Virtual object manager deals with all the virtual objects to be augmented in the real world. Virtual objects managers contain virtual elements also known as rendering objects. Whenever the author needs to add, delete, modify, copy and perform all other tasks related to 3D model, 2D model and multiple intelligence content, then it is redirected to virtual object manager. Even the path of the virtual objects is save for future use.

Various 3D transformation function such as like scale, rotation and position can be performed to define the desired spatial position of the content.

Augmented Content Management system receives inputs from the target manager (markers) and the virtual object manager (3D,2D and all related virtual models). Both the trackable objects and the render-able objects are combined to provide a AR view. The author can augment additional intelligence features for the specified content. Content providers, provide the necessary stored multiple intelligence content input to the augmented content management system

c. Authoring an Adaptive and Interactive Story Telling System

It is divided modules such as story manager, context database, marker manager, story modeling 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 exist 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,VR 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 new contents 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/VR 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. Finally, story editor is where the story is generated and forwarded to story validator for validation. The continuity of the events is also validated in story validator. 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.

d. Algorithm

FUNCTION HRMACE-MRA

Step 1: start

Step 2: check for USR_VALID

3: if (USR_VALID=T) go to step 5

4: quit

5: if (CONT_EXPER=YES) go to FUNCTION 4R

6: else if (CONT_CREAT_MI=Y) go to FUNCTION AMICMS

7: else go to FUNCTION AISTMAR

8: end

FUNCTION 4R

Step 1: Create learning objectives for (STEM)

Step 2: Initialize the learning objects

Step 3: Pre-test

Step 4: Visualize and view the ADAR learning information

Step 5: Post test

Step 6: The collected data are analyzed and divided further based on Research(Res)[R1], Reasoning(Rea)[R2], Reflection(Ref)[R3] and Renaissance (Ren)[R4]

Step 7: In each of Res, Rea and Ref calculate the cognitive, skill and attitude of the control and experimental group (Random group)

Step 8: Measure and evaluate the Res (c), Res (s), Res (a), Rea (c), Rea(s), Rea(a), Ref (c), Ref(s) and Ref(a)

Step 9: Combine the Res, Rea, Ref and Ren

Step 10: if (the learnability is satisfactory) then forward to next mode

Step 11: else repeat the same learning process after a time interval

Step 12: End

FUNCTION AMICMS

Step 1: If (user=valid) then go to step 3

Step 2: Else quit

Step 3: If (option ATASK_CONTCRET=YES) then go to step 5

Step 4: else go to FUNCTION VIEW

Step 5: design REL_MARKER through ACMS

Step 6: if (3D || 2D MI_CONT_RET FROM _VO_MNGR) then go to step 8

Step 7: Else CREATE_MI 3D || 2D CONT through ACMS

Step 8: Assign the marker for MI_3D_content (this task is performed by augmented content management system)

Step 9: if (ADD_AUTHORING =YES) repeat from step 5

Step 10: else go to FUNCTION VIEW

Step 11: end FUNCTION

Function 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
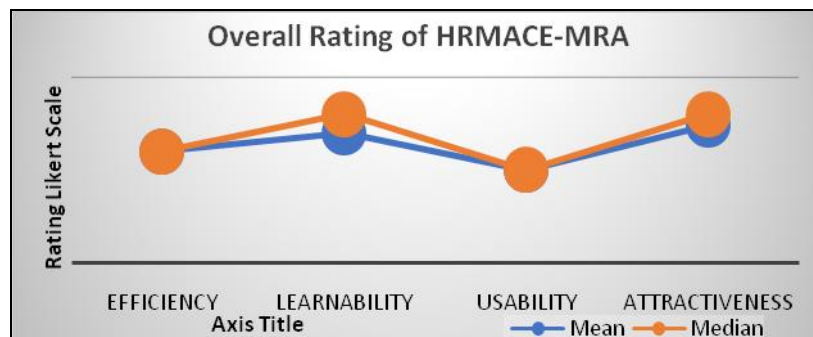
IV. RESULTS AND DISCUSSION

Figure 2: Overall rating of HRMACE-MRA

Figure 2 shows the overall rating of HRMACE-MRA in terms of mean and median. The rating was given in likert scale. Various factors such as efficiency of the entire system, learnability and enhanced learnability factor,

usability level of the entire system in terms of User experience, user expectations, user centered design, user interface design and user acceptances. Finally, the attractiveness of the system was also taken as rating factor. A positive and promising rating was achieved which proves that when content experience and content creation was combined better usability is obtained.

Figure 3: Effectiveness ofHRMACE-MRA

Effectiveness refers to the accuracy and completeness with which users can achieve their goals. Typical measures include Objective measure of quality of output, Number of errors per unit of time,percent of users able to successfully complete the task, percent of users who can carry out key tasks without reading the manual. Number of requests for assistance accomplishing task, Percentage of tasks completed successfully on first attempt, Percentage of relevant functions used,number of errors made performing specific tasks,

Objective measure of quantity of output, number of power tasks performed and number of persistent errors. Figure 3 shows the graph of the effectiveness measured with reference to goal achieved and goal not achieved
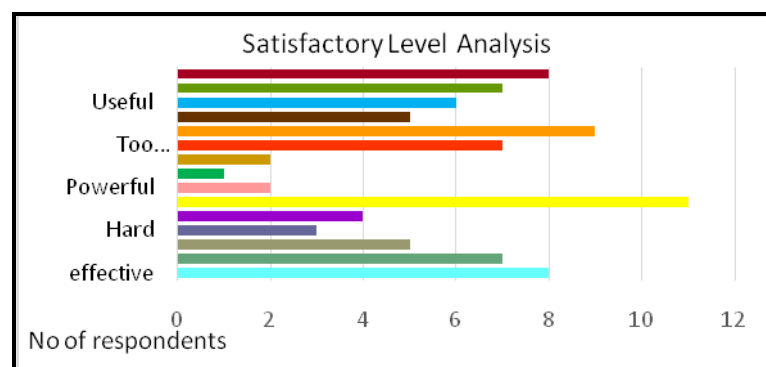

Figure 4: Satisfactory level Analysis

Figure 4 shows the satisfactory analysis graph. Various measuring factors such as fastness, effectiveness, powerful, user friendly, hardness, uncontrollable, usefulness, inflexible, helpful, too technical, high quality, slow and powerful were the analysis factors used to determine the satisfaction level of the system. Remarkable result proved that the introduced and executed system was much more satisfied than the existing system.
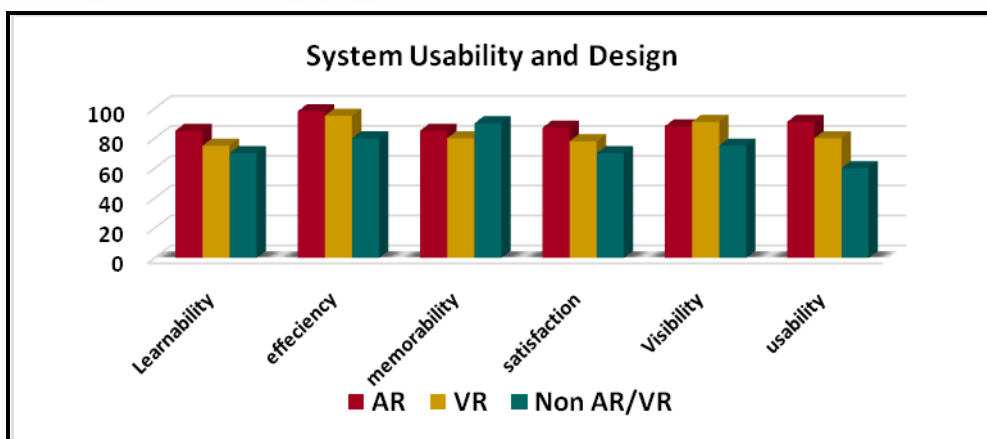
Figure 5: System usability design for existing and proposed method

Figure 5 shows the comparison study of system usability and design of three different learning ambiances such as augmented reality ambiance, virtual reality ambiance and non AR/VR ambiance.The factors taken to analysis three different learning ambiances were learnability, efficiency, memorability, satisfaction, visibility and usability. The results obtained shows that maximum number of respondents enjoyed augmented reality based learning ambiance followed by virtual reality ambiance and finally non AR/VR environment.
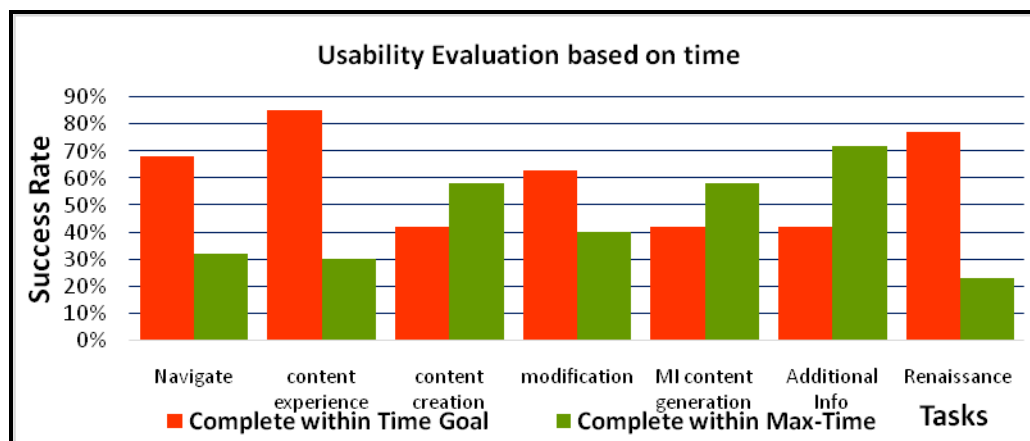

Figure 6: Usability evaluation based on time

Figure 6 shows the usability evaluation based on time. Task versus success rate was measured. Completion within time goal and completion within maximum time were two evaluation factors. It was measured based on various task such as navigation, content experience, authoring, modification, multiple intelligence based content generation and additional information. Maximum numbers of tasks were achieved within the time goal. Almost all the task wasattained within the given maximum time.

V. CONCLUSION AND FUTURE WORKS

MAR is a potential tool to fill the gap between the content experience phase and the reality. In this study, a mixed reality based content experience learning approach is proposed which enhances the learnability with a reduced time level. The content experience and the reality are merged and the existing gap is filled through Mixed reality. 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 proposed HRMACE-MRA algorithm gives an effective result for content experience module, when action is separated from research, reasoning, reflecting and Renaissance and thereby when the specific factor were the learner lacks are identified then simulation of interest (motivation) is achieved after a specify time interval. Evaluation based on intelligent quotient and emotional quotients were added advantages.

Mixed reality based content management system to author and evaluate the multiple intelligence of the user is also suggested in authoring mode. Many development cases were examined to prove that our system is more simple, effective and efficient system for authoring. The research conducted also proved that mobile augmented reality technology based adaptive and interactive way of storytelling was more perfect comparing to the traditional way of storytelling.

More research efforts should be done in this area especially in providing and standard and consistent authoring framework. It can also be extended combining cloud based technology, AR authoring and response for Big data and AR authoring with context view point. Immerging augmented reality in ubiquitous learning will be next generation technology.

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