Augmented Reality Based Computer Assisted Maintenance

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Abstract : Augmented Reality (AR) is a rising innovation that can be utilized to join the physical world with virtual world through visual interface. It expands this present reality by superimposing virtual universes to give more helpful data. The innovation can be connected for learning, diversion, training, or promoting by improving a clients impression of and association with this present reality. Along these lines we propose an AR-based upkeep framework which used to help administrators in support and repair rules applied to computer hardware maintenance. The proposed system will track 3D objects and augment the necessary maintenance instructions. These instructions may contain text ,image or 3D models. Also it will have facility to reconfigure the procedure if needed on operators demand. The system would evaluate by time required to complete maintenance operation as compared to paper based instruction

IndexTerms - Augmented reality,repair,maintenance, virtual reality,reconfigurable procedure, hardware maintenance

1 Introduction

A. Overview

Augmented reality (AR) is an innovation that enables virtual pictures to be flawlessly blended with this present reality. AR remain between virtual reality and genuine condition. AR is a live ,immediate or backhanded, perspective of a physical, certifiable condition whose components are increased by PC produced tactile info, for example, sound, video, designs or GPS information. Then again enlarged virtuality is an innovation that improves the clients reality by embeddings a genuine question into virtual condition. There are two sorts of increased reality: marker-based which utilizes cameras and visual signs, and marker less which utilize positional information, for example, a mobiles GPS and compass

Fig. 1. Taxonomy of mixed reality including real to virtual environments

Augmented Reality is a type of virtual reality that aims to duplicate the worlds environment in a computer. Virtual reality (VR) is a manufactured, PC produced reenactment or diversion of a genuine domain or circumstance. VR is commonly accomplished by wearing a headset like Facebooks oculus outfitted with the innovation, and is utilized noticeably in two distinctive ways .

To upgrade preparing for genuine condition by making a reproduction of reality where individuals can hone previously .

Enlarged the truth is portrayed by the joining of fake or virtual components into physical world ,normal sort incorporates projection, acknowledgment , area and blueprint.

- Projection-It is common type of AR, it uses virtual imagery to augment what you see live.
- Recognition-It recognizes shapes, faces or other real world items to provide supplementary virtual information to the users in real-time.
- Location-It uses GPS technology to instantaneously provide you with relevant directional information.
- Outline- It combines the layout of the human body or part of body with virtual materials, enabling the client to get and generally control questions that don't exist truly.
- Enlarged Reality can be connected for learning, excitement, or edutainment by improving a client's impression of and collaboration with this present reality. Client can move around the three-dimensional virtual picture and view it from any vantage point, much the same as a genuine protest.

The application work flows when an AR application is launched on the client side device it display to the user a list of procedure that are locally available. The user starts to follow the procedure by framing the sense with device camera. When AR system recognize the CAD model to the current step, it starts tracking its pose and overlaps the associated 3D assets onto it. When current state is completed by pressing the next arrow icon the AR system starts looking for the CAD model configuration associate with the next step.

- Camera : Displaying this live feed to the camera as the reality in augmented reality. This live video stream is given as an input to the Image Capturing Module.
- Image Capturing Module : This module generates binary images i .e. a digital image that has only two possible values for each pixel. These binary images are provided as an input to Image Processing Module.
- Image Processing Module : Inputs to Image Processing
- Module are the binary images from Image Capturing Module. These binary images are processed using an image processing technique to detect the AR Marker. Detection of AR Marker is essential to find the position, where to place the virtua object. As the AR Marker is detected, its location is provided as an input to the Tracking Module.
- Feature matching module : After detecting the features, the system needs to match them, i.e. it needs to find corresponding features in different images. Feature matching compare the small image areas around the features and find similar areas, or they calculating image characteristics around the feat ures and compare them.
- Rendering Module : There are 2 contributions to Rendering Module. To begin with is the figure posture from the component coordinating Module and other is the Virtual video to be increased. The Rendering Module joins the
- first picture and the virtual segments utilizing the ascertained posture and renders the increased picture on the show screen of the cell phone.

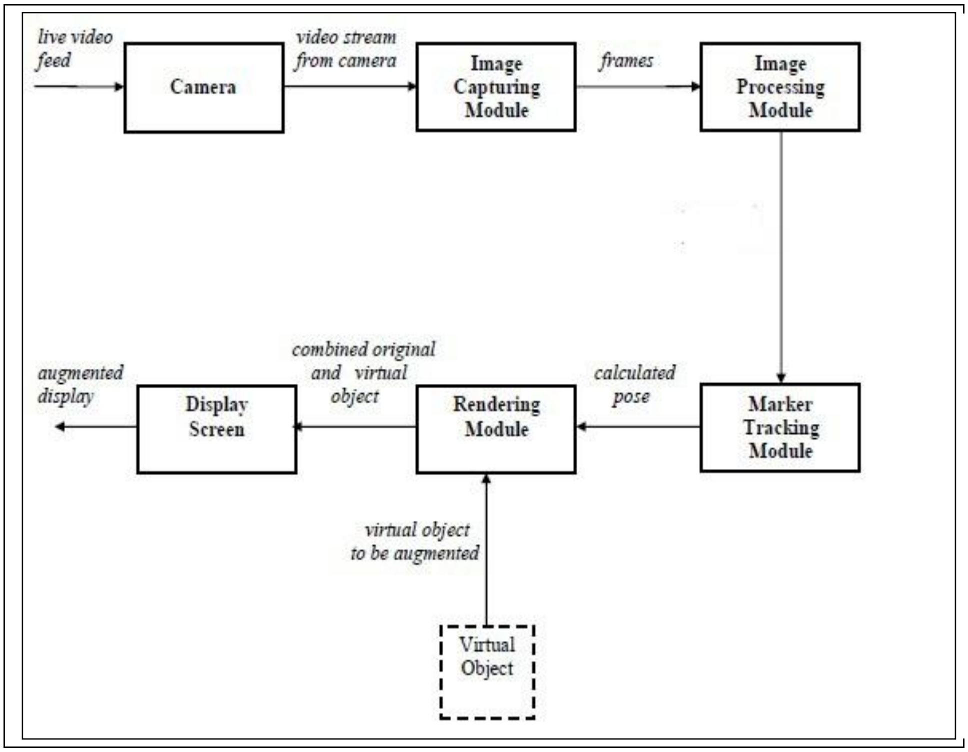

Fig. 2. Basic block diagram of AR

II. Review Of Literature

Various kinds of literature has been surveyed which include standard conference and journal papers, help documents, user guides, tutorials and books. Also a systematic review of AR based educational prototypes i done for evaluation of their usability in educational settings. The reviewed literature is divide in three categories as:

- E-learning and pedagogy
- AR in e-learning: usability evaluation
- web2.0 n e-learning
- Combined use of Web 2.0 +AR +LMS

For augmented reality learning experiences, the authors Marc Ericson et.al. have reviewed various prototype designs. They have also proposed the relationship of AR affordances with Multimedia learning theory and have suggested guidelines for future AR applications.[6] The author Mihaela Filofteia has studied ARs application fields, usage statistics in world through a questionnaire based survey and online documentary search. The survey about usage of AR tells that AR is mostly used for gamin apps and entertainment. Then it is used for location based services and then for educational purposes [25].

A. AR in e-learning: usability evaluation

The purpose of a systematic review is to find how much of ARs benefits are applied with e-learning systems. The primary objectives of this survey are:Usability evaluation of AR based systems and benefits they achieved and Finding usability of AR along with web 2.0 tools in educational systems.

1) Meta-analysis : Analysis of articles show that the effects associated with technology have not changed substantially over the years. The mean effect size of technology applied to education observed is 0.56 or low to moderate effect. The methodology for the systematic literature review is as follows:

Search for prototypes: A literature search was conducted in year 2013-2014, published in IEEE Xplore Digital Library, ScienceDirect, Springer, and Elseveir etc. The search is limited to journal articles and conference proceedings that are written in English.

Inclusion criteria: The content relevant to educational applications and focusing on higher education was considered for this survey. Thus, for the research to be included, the following criteria. must be met:

- The research paper must have at least a preliminary working ARLE prototype.
- **The content should be relevant to secondary or higher education.**
- The paper reports an effect size or provided a means to calculate the effect size (reports both mean and standard deviation).
- **Data gathering:** We computed the effect size (d) using formula
- d = (xe + xc)=s
- Where, xe is the mean of experimental treatment that using AR and xc is the mean of control and s is pooled standard deviation obtained as:
- s = (se + sc)=2
- Where se is standard deviation of experimental treatment and sc is the standard deviation of the control. We interpret the calculated effect size based on Cohens recommendation, that is, an effect size of 0.8 or higher is considered large, around 0.5 is considered moderate, and around 0.2 is considered small.
- **2) Qualitative analysis:** The usability of AR in education is mostly evaluated using survey questionnaires and personal or group interview methods. Some researchers have used combination of such data collection methods.
- **Search for prototypes:**
- Search for prototypes was carried out in the same way as in meta analysis. The articles considered for meta analysis are also included for qualitative analysis.
- **Inclusion criteria: For inclusion in qualitative analysis, we focused on the evaluation technique and benefits achieved. So, the criterion for effect size was relaxed.**

References	Contents	Participant	Control Group	Exp. group	effect
[14]	Game of go	18 volunteers	PC based Go Game learning	AR based ARGO GAME	0.23
[15]	Interactive agent	15 Students	Collaborative e-learning to speak	AR Based interactive agent	0.53
[16]	OOP course	200 students	E-learning approach using LMS	AR based Course content	0.8
[17]	English Language	6 classes	Text Based Audio	Ar based immersive	0.49

	course		visual data	learning	

Data gathering: A survey questionnaire was drafted to facilitate the gathering of data from the 10 included articles. The questionnaire has four main parts namely:

- publication details,
- prototype description,
- use of AR,
- design and results of the user
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B. Results of systematic review of AR prototypes

1) Meta analysis results: There were four articles which reported their values of experimental evaluation. The AR applications used for education and their effect sizes are summarized in Table I. The mean effect size obtained is 0.511 which is moderate.

2) Qualitative analysis results: We selected ten articles having educational prototypes according to given inclusion criteria. The usability of AR in education is mostly evaluated using survey questionnaires and personal or group interview methods. Some researchers have used combination of such data collection methods. The prototype descriptions and tools described in each article are summarized in Table II.

Most articles reported have used questionnaires and evaluated results based on Lickert scale. [14] has used questionnaire based on IMI that is the researchers used a part of the Intrinsic Motivation Inventory (IMI) to analyze four subscales: enjoyment, competence, usefulness, and tension.

C. Web2.0 and e-learning

Some articles report that due to collaboration and content creation is allowed for end user in Web 2.0 technology, learner engagement and improvement in creativity and motivation have been observed with the use of Web 2.0 in TEL. There are some web2.0 based tools designed for teaching and learning can be integrated with LE's like Dabbleboard, Media-wiki etc.

Web 2.0 technology has support for collaboration, social interaction, creative thinking of students in e-learning environments. Anastasios K. et. al. have done evaluation with a goal to identify how to design and deploy adaptive Computer Supported Collaborative Learning (CSCL).The authors report about the tools like GLUE! and WebCollage for integration of web 2.0 and LMS for adaptive collaborative support. They also compare various available integration tools.[23]

D. Combined use of Web 2.0 +AR +LMS

Authors in [12] presented a review of research that has been done at University of Panama for the use of Metaverse (virtual world) based on free VLE and their application in electronics. Virtual circuit was prepared to change in color codes and verify resistance and vice versa.Also they have used of AR with support of high definition web camera and OpenCV .

An augmented interactive learning approach has been presented in[3] They examined different educational activities with Social learning in combination with VLE, the platform is capable of supporting learning. They also report that more educational activities such as library, career services should be implemented in AR and blended learning should be enhanced. AR in chemistry teaching with cognitive test for students, evaluation according to capability of scoring. They conducted a pre-test and a post test for students before and after experiencing AR in LE. They report that students who have weak performance get more benefit from AR prototypes.[16]

Some researchers have developed to use benefits of both AR and web 2.0. Hoang et.al.[19] have developed a system which uses wearable device enabled with AR interface to share social network information which can capture location information using GPS co-ordinates. Such kind of efforts are extende for combinig GPS based augmented information web 2.0 support by introducing ARML2.0. ARML 2.0[26] is an XML grammar thal lets developers describe an augmented scene, the objects in the scene, and some essential objects in the scene.

Paolo M. et.al.[12] say that Journal articles now can increasingly include a variety of sup- plemental multimedia and interactive materials for augmented reading that will impact both the nature and presentation of scientific research. The main findings from review are AR and Web 2.0 both have been studied for their benefits in e-learning. But combination like ARML 2.0 has more scope in e-learning application in study tours or the outdoor activities. Also marker based AR and web 2.0 based tools can be combined with LMS for initiating various learning activities.

Such prototype designs can have benefits like increased engagement, motivation, creative thinking, harnessing collective intelligence etc. Such prototypes must be evaluated using specifically designed questionnaire. Also students performance before and after using prototype must be recorded .

From the above review, we can say that AR can be implemented in various ways like annotation with real world images, popup books to support learning. We can use it alongside web2.0 based e-learning system. The available library functions or tools and interfaces can be effectively used for developing an immersive and more enjoyable learning environment.

III Software Requirement Specification

IV

A. Overall Specification

In this section SRS for a software system is like a complete work or description as well as behavior of a system to be developed.

- The implementation of our AR system we use Vuforia. In Vuforia various solution available we use this tool because of its popularity and license-free nature .
- The user interface Vuforia code is implemented using both the Android APIs and Visual C sharp Graphical user interface.
- The Operating Environment of our system like iOS, Android, Windows and Vuforia SDK tool is support for that environment etc.

B. External interface requirements

Software required:

- Moodle (includes XAMP- Apache, MySQL, PHP)
- Vuforia SDK
- Visual Studio2012 ultimate

Hardware required:

- Desktop PCs
- Handheld device (Tablet / smart phone with camera)
- Web camera

Communication Interface:

- HTTP and SOAP for communication between server and clients
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IV. System Architecture

Fig 4 shows proposed system architecture the proposed system basically designed for AR based maintenance. The client side uses a mobile AR application specially designed for onsite technician/user. This application will be built by using Metio SDK or OpenCV. The server side consists of ASP.net application

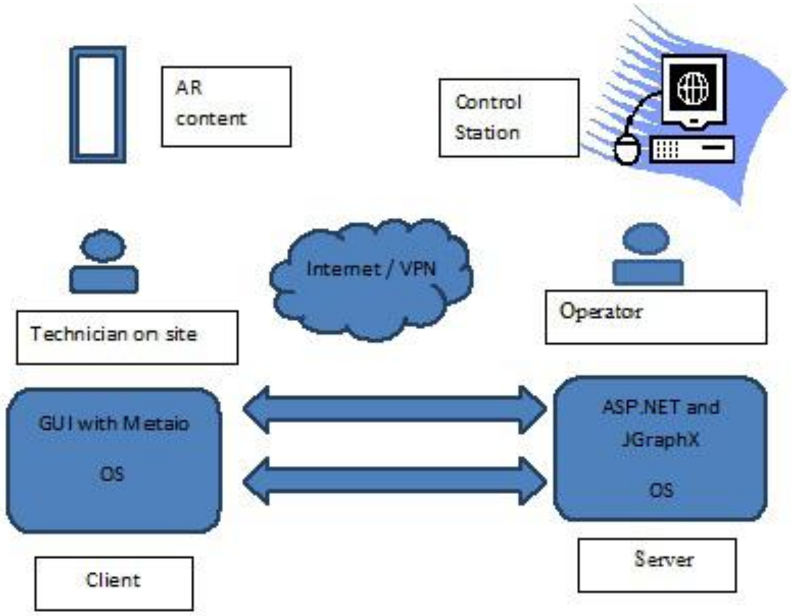

Fig. 3. System Architecture

A prototype architecture of the proposed framework is illustrated in Fig. 4. The framework has been developed by implementing an agile methodology. Specifically, four basic tasks have been identified: user requirements collection and analysis, design, implementation and testing.

A. Flow of Application

Fig. 4. Client application flow with AR

Fig. 5. Server application flow with AR

B. Overall description of system

AR-based maintenance procedures will be used to support operators in maintenance and repair procedures applied to computer hardware maintenance. To define the scenarios here after described, end-users got advantages from the state of the art technology. It helped to gain awareness with AR and best-fit the applications. Moreover, a questionnaire to be submitted has been arranged to assemble end-clients' necessities as far as ease of use and application on the field with a specific end goal to drive the following stages of outline and execution of the AR-based instruments.

Circuit board components are closely positioned thus it is challenging to train maintenance operators on a well-defined product. On the other hand, AR technologies can provide valuable support. In particular, the operations that will assess AR-based solutions are listed hereafter

- Operation- ordinary maintenance operations. AR will support and guide standard maintenance operations, such as cleaning of RAM chips, USB ports and NIC ports.
- Operation- repair operations. AR will support and guide common repair operations, such as the repair of SMPS or graphics card.
- Operation-technical manual instructions. AR will support and guide routine machine assembling procedures.

To implement AR tools as support for maintenance activities, videos, images and CAD based 3D models will be used to computerize the specific maintenance activities selected. The maintenance activities have been chosen because of their complexity. The implementation of AR tools will allow to interactively support and guide technicians and/or customers in the ordinary maintenance activities. After a preliminary selection of maintenance, different technical procedures would be investigated and implemented. The main feature of proposed system is its reconfigurability.

C. Example Scenario of Maintenance Process

For applied research problems like proposed one, functional and non-functional evalua- tions are necessary. Improvements in students performance can be the functional outcome of the system whereas increased engagement of students with learning activities and their satisfaction can be termed as nonfunctional results. Therefore system evolution technique must include evaluation for both types of outcomes.

Consider a simple example cleaning of a RAM chip on motherboard. The operator is supposed to identify RAM chip , remove it from its slot then clean it and insert it back on its slot. The system will guide the operator to perform this operation in following way

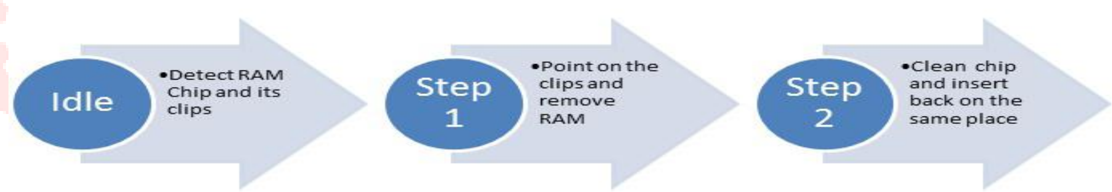

Fig. 6. Standard step sequence

The Fig.7 shows standard step sequence. The system will load 3D tracking and rendering models associated with that step. In a case when the operator identifies the chip but cannot find its clips then the above given standard step sequence is changed. The new steps will be added to the procedure on operators demand as shown in Fig 8

Fig. 7. Reconfigured step sequence

Different scenarios will be evaluated in order to assess and compare, in a quantifiable manner, the impact of AR technologies on maintenance procedures. Some objective parameters will be used to assess the proposed tools and results will be then compared to the current maintenance/repair procedures. In the situation portrayed above, AR arrangements are relied upon to be utilized for remotely supporting specialists, by methods for a tele-help approach, in repair and upkeep assignments for proposing, processing and stone cutting machine instruments. Regardless of the vertical area, the task intends to build up an exible system to enable specialists at the central command to powerfully reconfigure/change AR strategies to be actualized by experts at the client's site.

D. Assessment Criteria

Different scenarios will be evaluated in order to assess and compare, in a quantifiable man- ner, the impact of AR technologies on maintenance procedures.

(A) DETECTING SIFT FEATURES:
BEGINLOOP
Set $t_{sift} = t_{now}$.
Detect SIFT features from Frame(t_{sift}).
Identify the SIFT features.
Indicate that SIFT features are READY.
ENDLOOP

(B) TRACKING FEATURES:
BEGINLOOP
IF there are tracked features,
Optical Flow: Frame(t_{now}-1) $\rightarrow$ Frame(t_{now}).
RANSAC with epipolar constraint.
ENDIF
IF SIFT features are READY,
Introduce new features.
Optical Flow: Frame(t_{sift}) $\rightarrow$ Frame(t_{now}).
ENDIF
ENDLOOP

Fig. 8. Algorithm for object tracking and recognition at client side

Some objective parameters will be used to assess the proposed tools and results will be then compared to the current maintenance/repair procedures. The quantified targets are listed below:

Completion time of tasks; a reduction up to the 20-30 per of the time necessary to complete the above mentioned procedures is expected

- Number of errors of the operator in perform a given maintenance task; it is expected the operator will be able to complete the given tasks reducing the number of error up to the 60per
- Reduction up to the 30per of costs of maintenance procedure;this parameter is strictly related to the time necessary to complete the procedure.
- Improved environmental sustainability, in term of estimated reduction of CO2 footprint (-15-20per) thanks to the adoption of the remote assistance platform Moreover, qualitative feedbacks gathered from operators will be also considered to evaluate the proposed tools.

V. PROBLEMS AND IMPLIMENTATION

This section present technical problems and development of AR-based applications for supporting maintenance and assembly tasks.

The Starting problem is capability of AR applications to recognize objects in the real world and track their pose. Approaches based on the use of artificial elements, like markers, displaced in the environment (e.g., sticked to the objects to be tracked) are very robust and work fine. Training the system to work with such elements is also quite easy, since they are designed to be clearly different. However, it is not always possible to add such information. Hence, a tracking based on natural features, i.e., on object characteristics that are inherently available, is often desirable. For this situation, the following framework can be prepared fundamentally in two routes: by pictures, or by 3D models.

With the main option, preparing is performed by gathering a few pictures (alluded to as preparing pictures) of the genuine question from various perspectives. Preparing pictures are handled disconnected with a specific end goal to recognize and extricate a specific number of alleged picture descriptors. Amid operation, the above handling is rehashed online on pictures assembled by the client gadget's camera. When a match between offline and online computed descriptors is found (a threshold is generally set to define recognition precision and robustness), the tracking step can be executed, thus correctly aligning virtual objects to the real ones. Unfortunately, this approach is strongly dependent on environmental conditions as well as on possible changes in the surface of the real object with respect to what is actually pictured in the training images .Distinctive lighting, reflections, shadows, clean, earth, rust, and so forth may bargain both the acknowledgment and the following of the question. A conceivable arrangement could comprise in supplanting preparing pictures with photorealistic renderings. Starting from 3D models of real objects, it could be possible to simulate and render different environmental conditions as well as different settings.

The drawbacks are related to the overhead due to the modeling phase of polygonal and line representations, which can be a serious constraint for the development of ”homemade” applications. The second main problem is related to system reconfigurability. AR maintenance applications are usually designed to support a set of procedures that consist of a fixed number of well known steps. The design of a state diagram is at the basis of any procedure. Each state corresponds to a well defined step of the procedure and system behavior needs to be clearly specified by means of state transitions. However, a dynamic reconfiguration of the state diagram that might be required, e.g., to deal with unexpected situations not contemplated in the existing procedure, is, in general, a very complex task that is hard to be performed at runtime.

A. Evaluation techniques

For applied research problems like proposed one, functional and non-functional evaluations are necessary. Improvements in system performance can be the functional outcome of the system whereas increased engagement of various object and it’s maintenance activities and their satisfaction can be termed as non-functional results. Therefore system evolution technique must include evaluation for both types of outcomes.

- Users have no prior knowledge about the contents of our AR application
- For the experimental group, AR prototypes will be used along with other content and for control group; Repair or Maintenance is done without AR prototypes.

After completion of our task, a test will be conducted for On site technician groups and results will be compared for analyzing effect of using AR technology.

VI. Conclusion

According to the various surveys done for AR applications, it has proved that AR is a technology ,that can be exploited to provide its users an effective and customizable support. Mobile devices such as smartphones and tablets, are playing a key role in the exponential growth of this kind of solutions. The proposed system will be utilizing these features of AR and improve effectiveness of todays maintenance process. It also helps in reduction of repair time and costs, a reduction up to the 20-30 percent of completion time is expected as compared to paper based maintenance process

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