AUGMENTED REALITY IN ENGINNERING GRAPHICS

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***Abstract* — Engineering graphics (EG) is the subject of transferring information from design into manufacture. Developing ability to create and read graphical representation of engineering structure is essential for individual. Therefore, training engineers able to use the graphical language to communicate is vital in every engineering college. However, in the classroom, where lecture time is limited, it is hard for the instructors to illustrate clearly the relationship between the 3D geometry and their 2D projection using only one kind of presenting technique. This work gives a brief insight into the potential and challenges of using Augmented Reality (AR) in Engineering Graphics Education. An AR-based system specifically designed for EG instruction were studied and developed. The system aims at improving the spatial awareness and interest of learning.**

***Keywords* — Unity Framework, Augmented Reality, ARToolKit SDK, Vuforia Engine, Tracking.**

I. INTRODUCTION

Augmented Reality in Engineering Graphics System allows users to view a 3 dimensional structure of any 2 dimensional view by using Augmented Reality to display the output 3D model on to the screen using simple techniques. The study shows that humans are more comfortable to study things which they can see with their eyes rather than hearing and imagining, therefore applying this concept to learn engineering graphics our system helps the user to actually see what they are supposed to do. The main objective of augmented reality in Engineering Graphics System is to enhance the ability of a student to understand and implement the concepts of engineering graphics. Students can turn the pages of these books, look at the problem inside the book, and finish their assignment much the way they are reading and writing on an ordinary sheet. However, if they focus a camera on the marker, a 3D virtual models pop-up in the computer screen over the real pages. The virtual models superimposed upon the real page will serve as the tip for imagining the relationship between the 3D geometry and their 2D projection.

Fig. 1. Examples of AR markers embedded in the graphics materials

II. EXISTING METHODOLOGY

Authors have developed an AR based support system for teaching hand drawn machine drawing used for used for training of sketching and orthographic projection drawing in which users can watch virtual object from various orientation. This system developed using ARToolKit which overlays a virtual mechanical 3D object recognized by a cubic AR marker on the screen [15]. The position and the orientation of the AR marker define the position and orientation of the virtual object. During the registration process direction and distance of virtual object from the camera is calculated through recognizing edges of an AR marker process. User can watch 3D object in various aspect like front, back, top, under, left and right through rotating the cubic AR marker.

Researchers have built advanced gardening support system called the Smart Garden (SG) which provides information about what to plant where. Guides user of planting seedlings where different symbols on the screen indicated steps to be taken also virtual plants are overlaid on real image which helps growers to understand the outcomes of their decisions intuitively. SG uses NyARToolkit for processing. Fiducial marker, a square black frame with unique symbol inside, is used which differentiate markers. Fiducial marker is recognized in the image captured by the camera and the positions and orientations of the markers relative to the camera are calculated.

In AR applications, the students can interact with real, physical objects around them while virtual models are being added to this world. Using this technique, they have a better perception of the objects they observe. The same mental rotation test was repeated with AR models to investigate the benefits of AR models in assisting the students' graphic and spatial cognition skills. The questions of the AR assisted mental rotation test were prepared from the paper test. The 3D virtual models for the AR assisted test were generated by using a CAD system. The CAD models were then converted to AR models by using AR software. In this way, 3D virtual models can be displayed on the computer monitor together with the test paper containing the questions (see Figure).

Figure 2: AR assisted mental rotation test

III. PROPOSED SYSTEM

The proposed system makes the learning process using augmented reality all the way easier. It will add extra features to our existing System. It will remove the drawbacks of the existing system as time. This system examines the potential of an augmented reality system as an educational tool in an engineering graphics course. The students of that course will be able to observe 3D objects on the computer screen in a real-world environment captured from a webcam, with a special AR marker on a traditional 2D engineering drawing. The developed AR interface can display different 3D models and help engineering graphics students better understand drawings, geometric features and projection views. In addition, the AR interface can increase the students' interest and awareness in engineering graphics class assignments.

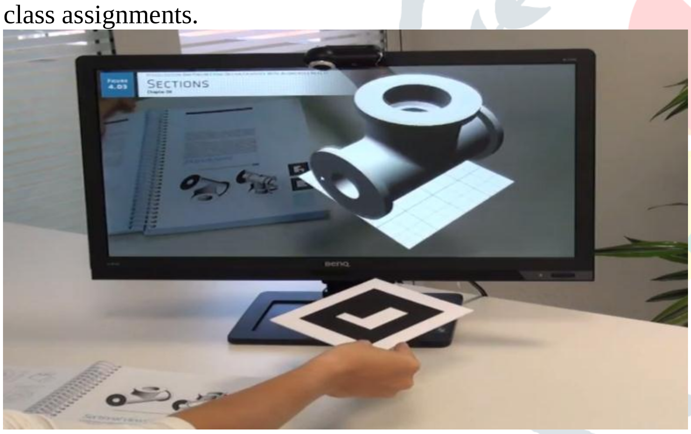

Figure 3 : Proposed System on desktop-based AR application

IV. SYSTEM DESIGN

Augmented Reality has Five Important Modules:

1) Tracking, Registration & Recognition
2) Gesture Computing
3) Operation Instruction
4) 3D Model DB
5) Rendering Engine

1) Tracking, Registration & Recognition

1.1} Recognition :

In the very first step of Augmented Reality, recognition is done with the help of recognition module. This uses any image, object, face, body or space on which object will be superimposed.

1.2} Tracking :

After completing recognition, next step is tracking which performed real-time localization in space on the input provided to system such as image, face, body or space and output of this step comes in the form of media of 3D type and it is superimposed over it.

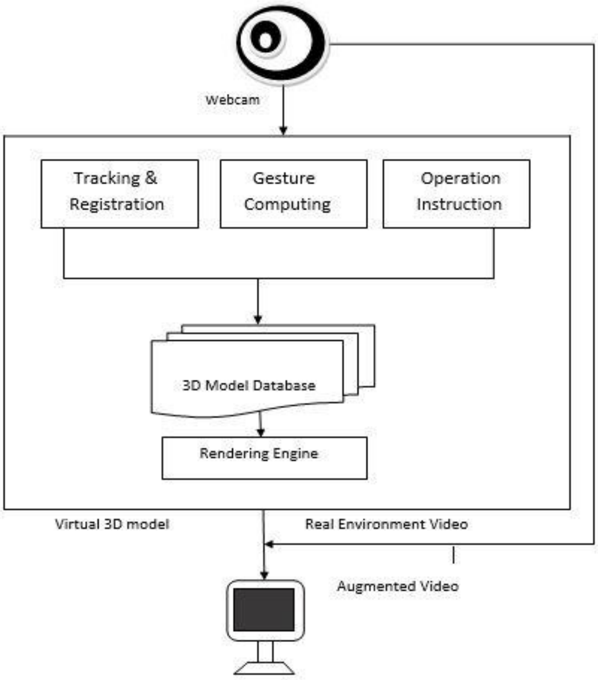

Figure 4: System Design

2) Gesture Recognition :

Gesture recognition is a topic in computer science and language technology with the goal of interpreting human gestures via mathematical algorithms. Gestures can originate from any bodily motion or state but commonly originate from the face or hand. Current focuses in the field include emotion recognition from face and hand gesture recognition. Many approaches have been made using cameras and computer vision algorithms to interpret sign language. However, the identification and recognition of posture, gait, proxemics, and human behaviors is also the subject of gesture recognition techniques. Gesture recognition can be seen as a way for computers to begin to understand human body language, thus building a richer bridge between machines and humans than primitive text user interfaces or even GUIs (graphical user interfaces), which still limit the majority of input to keyboard and mouse.

3) Operation Instruction :

Autodesk 3ds Max, formerly 3D Studio Max, is a professional 3D computer graphics program for making 3D animations, models, games and images. It is developed and produced by Autodesk Media and Entertainment. It has modelling capabilities, flexible plugin architecture and can be used on the Microsoft Windows platform. It is frequently used by video game developers, many TV commercial studios and architectural visualization studios. It is also used for movie effects and movie pre-visualization. To its modelling and animation tools, the latest version of 3ds Max also features shades (such as ambient and subsurface scattering), dynamic simulation, particle systems, grandiosity, normal map creation and rendering, global illumination, a customizable user interface, and its own scripting language. 3ds Max is used in this project to implement 3D graphical design models.

4) 3D Model Database :

Different components like Device Target Database, Cloud Target Database and Target Management System available on the developer portal (Target Manager) and Vuforia engine all of these are comprised into Vuforia platform. Tracking is done on the input image uploaded by a developer then desktop accesses the target resources directly from local storage. In Vuforia, camera captures frames from image and pass contents to the tracker then this image get converted by image converter into a format suitable for OpenGL ES rendering and for internal tracking. Computer vision algorithms detects and tracks real world objects in camera frames by loading and activating multiple dataset. All these tasks are performed by the tracker. Application Code which for newly detected targets query the state object which results in updating of application logic with new input data and rendering the augmented graphics overlay.

5) Rendering Engine :

In that we are using marker as input which is placed in front of camera and this marker uses physical world symbols as reference point for computer graphics images which are already stored in database of our system.

Camera continually takes snapshots of the given marker and process the image to its estimate orientation, position, virtualization and movement with respect to targeted object. We are using Fiducial marker for tracking module. It is very widely used technic to achieve result of Augmented Reality. This marker has very typical high contrast which is used in easy recognition in the field of view. This typical Fiducial marker used in Augmented Reality are only of two color types: black and white and these black and white markers are squares with geometric figures. Compared to other colors, black and white are basic color of nature which gives high contrast in background environment and so it is quickly recognized. Using it we can relate to point in space as well as calculate distance and the angle at which we have set locating markers.

V. CODING

After successful Modeling the next important task is coding. Coding refers to:

1. Computer programming, the process of designing, writing, testing, debugging, troubleshooting and maintaining the source code of computer programs.
2. The process of statistical classification of information.
3. Coding (social sciences), refers to an analytical process in which data, in both quantitative form (such as questionnaires results) and qualitative (such as interview transcripts) are categorized to facilitate analysis.

For User Side:
1. User starts the system.
2. User displays the marker in front of the camera.
3. User receives the corresponding 3-D output.
4. Stop.

For System Side:
1. System starts.
2. System receives the input marker from the camera.
3. If marker is identified then find the corresponding 3-D model.
4. Mount the 3-D model at the specified point.
5. Display the content to the user.
6. Stop.

Software's Used :

A requirement specification for software system is complete description of the behavior of the system to be developed and it includes the set of use cases that describe all interactions the users will have with the software. In addition to the use cases the SRS also contain nonfunctional requirements. Non Functional requirements are requirements which impose constraints on the design or implementation (such as performance engineering requirements, quality standards or design constraints).

1. .NET Framework 4.0
2. Visual Studio 2010
3. Windows 7.

Language Used : C # (C sharp)

VI. RESULT SET

The result sets of this system describe about the results which are derived after the project is tested. Result set shows how each and every module runs and what its result is. The result set are as follow:

1) Starting the System:

This is the initial screen using which the user is supposed to start the system. Figure shows the representation of the screen.

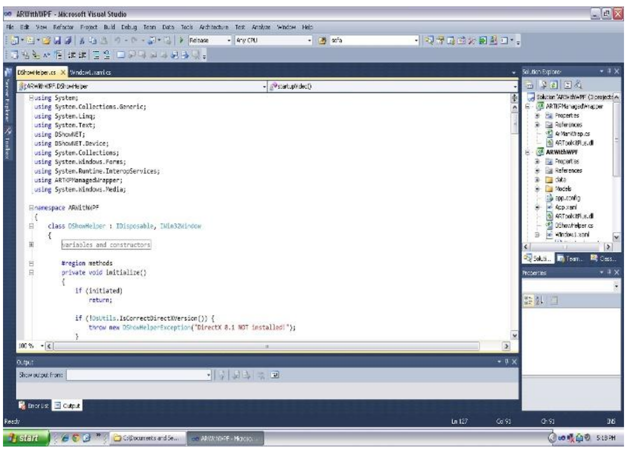

Figure 5: Starting System

2) Select The Input Component (Camera) :

The system prompts input component available to it. The user has to appropriate option for amongst the suggested devices.

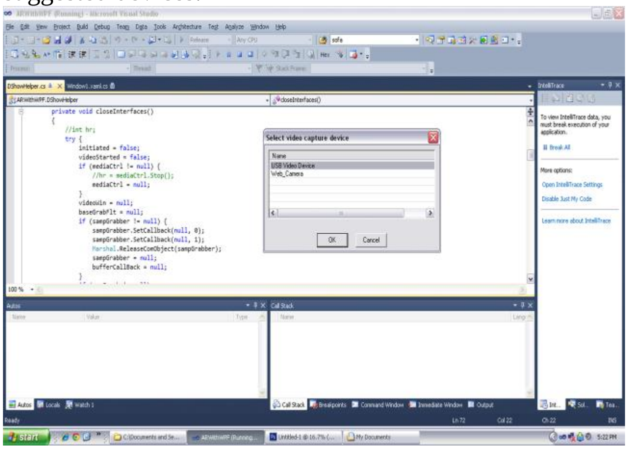

Figure 6 : Selection of Capture Device

3) Obtaining The Output :

1. After the previous step the user conforms the input component using which the system operates.
2. The user holds the input image containing the marker in front of the camera.
3. The system scans the input image and searches the previously stored images in the defined database.
4. After completion of the search the system find the most accurate result corresponding to the input image.
5. Using the previous result the 3D model associated with the marker is mounted at the point specified by the programmer.
6. Final output of the mounted 3D model is displayed on the screen which is visible to the end user as an augmented object.

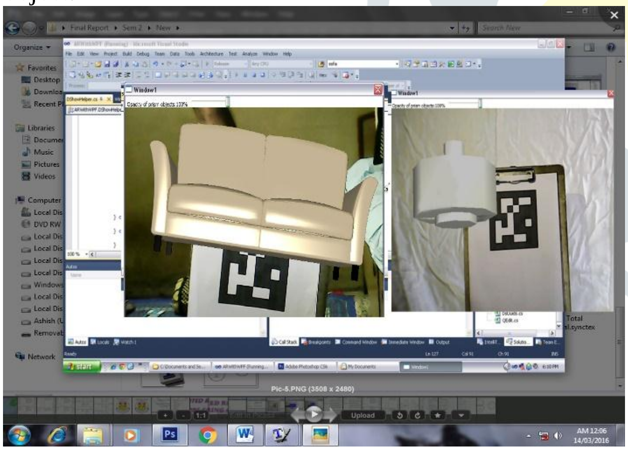

Figure 7 : Showing Output

VII. MATHEMATICAL MODULE

A mathematical model is a description of a system using mathematical concepts and language. The process of developing a mathematical model is termed mathematical modeling. Mathematical models are used not only in the natural sciences and engineering disciplines but also in the social sciences. Physicists, engineers, statisticians, operations research analysts and economists use mathematical models most extensively. A model may help to explain a system and to study the effects of different components, and to make predictions about behavior. Mathematical models can take many forms, including but not limited to dynamical system, statistical systems, differential equations or game theoretic models.

Set Theory :

Set theory is the branch of mathematical model that studies sets, which are collections of objects. Although any type of object can be collected into a set, set theory is applied most often to objects that are relevant to mathematics. A set is a collection of objects which are called the members or elements of that set. If we have a set we say that some objects belong (or do not belong) to this set, are (or are not) in the set. We say also that sets consist of their elements.
Set S= I, R, O
Where, I is set of all inputs giving to system.
R is set of rules that drives your input set.
O is set of output expected from system.

Venn Diagram :

A Venn diagram or set diagram is a diagram that shows all possible logical relations between a finite collections of sets. They are used to teach elementary set theory, as well as illustrate simple set relationships in probability, logic, statistics, and linguistics and computer science. A
Venn diagram is an illustration of the relationships between and among sets, groups of objects that share something in common. This type of diagram is used in scientific and engineering presentations, in theoretical mathematics, in computer applications, and in statistics.

Mathematical Model of the proposed system : -

1. **Design and Implementation Constraints (OOD) Mathematical Model**

- **Problem Description :**

Let us S be the technique set to transform an image into 3d model

Such that S = {I,F,O} where,

I = {I1}

I1 = Input images (N*M) to be transformed

Where, N = Number of Images

M = User

And F is the set of Function:

F = {F1,F2,F3,F4,F5,F6}

F1 = Set Marker

F2 = Import Packages

F3 = Track Marker

F4 = Object Recognition

F5 = Mount 3D Model

F6 = Display 3D Model

And O is the set of Outputs:

O = {O1}

O1 = 3D Model

2. Set Theory and Venn Diagram :

Here relations between the inputs, functions and outputs are shown. Venn diagram describes the graphical representations of all sets. From the Venn diagram we can say that, O < I.

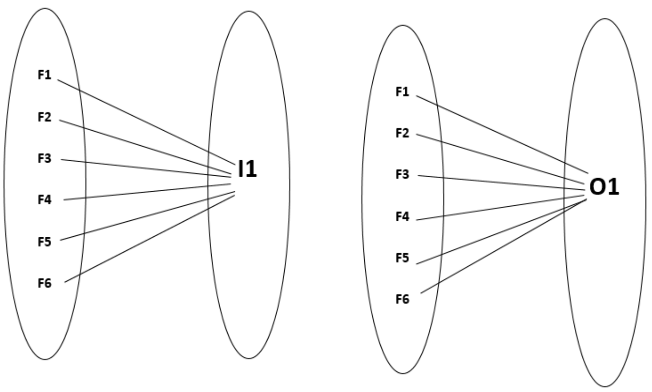

Figure 8 : Relation between inputs, function and outputs

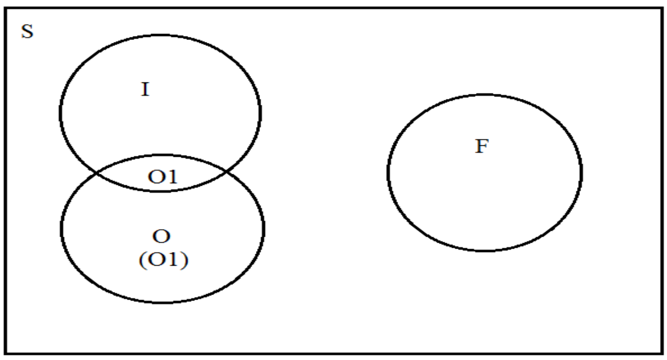

Figure 9 : Venn Diagram

VIII. CONCLUSION

Thus we have studied and completed the literature survey of this topic, Augmented Reality in Engineering Graphics. In that we studied different aspects of analyzing augmented reality applications. We completed the requirements analysis by studying the requirements of our project. In the design phase we have designed the working of the project.

The purpose of this survey is to provide an overview of the functionality of our Augmented Reality In Engineering Graphics System. Most of the systems use virtual reality and its applications. Hence we found that using augmented reality in learning process increases the ability to learn and helps to grasp better.

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