INTERACTIVE VIRTUAL ASSISTANCE USING PROJECTED AUGMENTATION

Submitted in partial fulfilment of the
requirements of the degree of
Bachelor of Engineering

by:

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CERTIFICATE

This is to certify that the project entitled

"INTERACTIVE VIRTUAL ASSISTANCE USING PROJECTED AUGMENTATION"

is a bonafide work of

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submitted to the University of Mumbai in partial fulfilment
of the requirement for the degree of "Bachelor of Engineering" in
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Project Report Approval for B.E.

This project report entitled **"**Interactive Virtual Assistance using Projected Augmentation" by Pratish Jain , Soham Mehta , Aayushi Vora is approved for the degree of Information Technology.

Examiners 1. _____

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Date:

Place:

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DECLARATION

We declare that this written submission represents our ideas in our own ideas in our own words and where others‟ ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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"Those who know, do. Those that understand, teach." - Aristole

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- Pratish Jain, Soham Mehta, Aayushi Vora
Dwarkadas J. Sanghvi College of Engineering

ABSTRACT

This project aims at making an interactive system where in all the necessary information required in the present world is presented to the user by augmenting the objects in the real world vision. This project addresses the overall problem of people, especially school children having the inability to imagine ideas. Specifically, our project addresses common "roadblocks" to learning faced by students, such as: limitations of understanding the theoretical concepts, a lack of analytical, critical thinking, and quantitative skills, differing cognitive styles, and a lack of comfort with advanced technology. The application of this not only limited to the school children but also for customers in a restaurant, who can visualize the dishes in front of them and also order from the app itself.

In our project, we demonstrate how studying electronic concepts learning can be made easy. Using the augmented reality, the project simplifies the learning process of understanding electronic devices, circuits and concepts. This application is mainly developed for the students, and it will be as simple as just hovering over the text or the image they want to understand. Automatically, the related data will be shown from the application database or from the cloud. The project lets enable students to make the concepts clear on a particular topic by simply using the smart phone and the intended book.

Thus, a concept of “Augmented Reality Books” has been developed which harnesses the power of augmented reality in one’s phone to recognize the specific page on that book and provide an extensive and intuitive augmented information pertaining to that page in the form of an image, video or its corresponding 3D model.

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Chapter 1

Introduction

The rapid development of new digital devices and technology has offered both innovative opportunities and challenges for instructional designers and teachers. Among the newer types of digital media, Augmented Reality (AR) will become common. Along with the development of a variety of software content, the rapid growth of hardware such as e-Book readers, tablet PCs, netBooks, electronic ink (e-ink), and electronic paper (e-Paper) transcend the limitations of paper books, which have the difficulty of updating the information with knowledge-cantered, and one-sided, linear learning materials. However, not everyone welcomes the coming loss of paper-based books, which have the strengths of transportability, flexibility and robustness, as an electronic book is clearly not equivalent to a real book with real paper pages. With the help of the release of augmented reality books which combine both real world and digital world, we are provided with an experience of mixed reality.

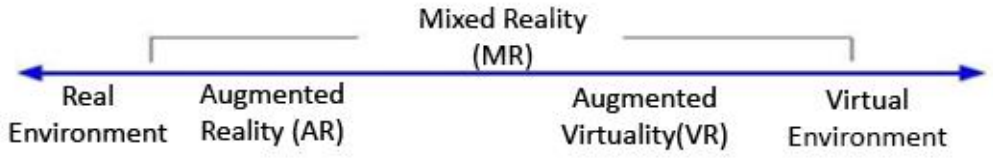

Figure 1. Mixed Reality Continuum

1.1 Problem Definition

Books have been used as a tool to support learning and acquisition of knowledge. The advancement in technology makes the book available in an electronic form. The electronic form of book is claimed to support various type of multimedia which make reading experience more interesting. However, the physical book is still more preferred as compare to the electronic one. This is because of the flexibility, mobility etc. Hence we propose to develop a system that uses concept of augmented reality for educational purpose in the form of AR Books. This system of AR Books will enable the user to hover the camera on any page and identify the content on it to obtain a more intuitive and augmented information. This will make the physical books more interactive. Thus AR Books also provide us with both the benefits and physical book such as mobility and e-books which provide explanation of each concepts. By means of AR books students can understand a particular topic given in a book so as to learn the content in a better way.
E.g.: In case of Electrical circuit, the AR book will identify the circuit by means of a marker (image recognition) and demonstrate the flow of the current through the circuit without actually developing the entire circuit.

1.2 Aim and Scope of the project

Main aim behind implementing this project is to develop a highly reliable system that is envisioned to be a mobile-based interactive Augmented Reality that does real time image and text processing and to represent this processed data in a form of 3D Models, media contents or any visual graphical format.

Scope of the project

- To develop a system that will provide the users with an interactive 3D model of the image and the term definitions for a given book.
- To analyse an image using marker recognition and markerless recognition.
- In case of text recognition, identify the term matching with the internal database and provide relevant information to the user.

Chapter 2

Review of Literature

The papers read gave us the direction of which technologies goes best with the defined problem statement proposed by the organization. The analogies detailed in the paper were helpful in better understanding the pros and cons of useful technologies.

2.1 Existing System

The following section talks about the previous systems which have been implemented and their respective pros and cons.

2.1.1 Existing System Study

A variety of research papers have presented different approaches for using augmented reality in different fields such as medicine, architecture, education, military and others. In this section, the following papers on augmented reality have been explored:

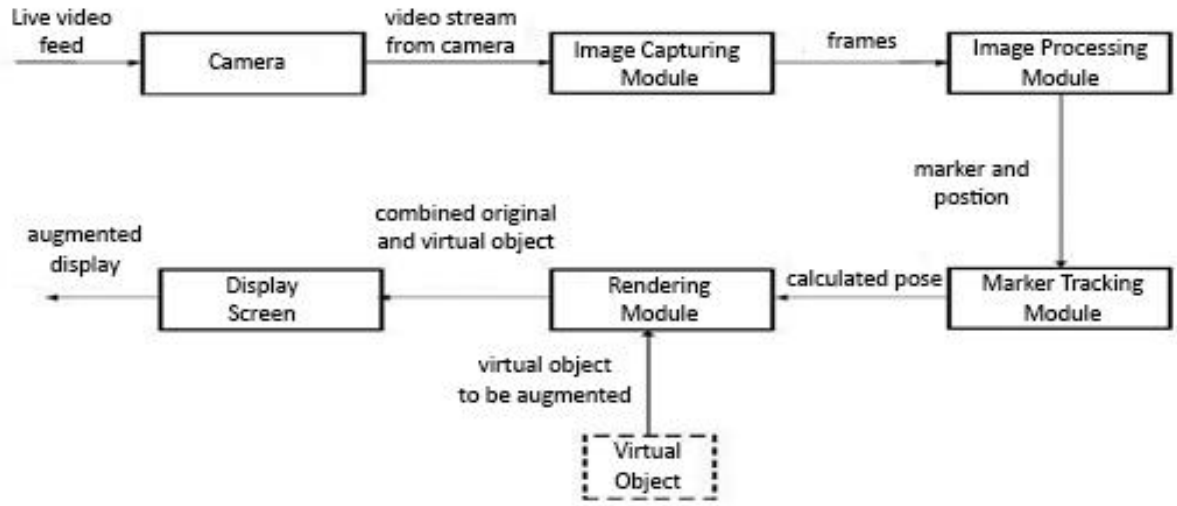

Figure 2: Existing System Architecture

The given architecture has multiple components such as the camera module, image processing module and mainly the rendering module. The existing systems with this type of architecture are:

- ***wARna***

  wARna is envisioned to be a mobile-based interactive Augmented Reality colouring book that extracts texture from the colouring book to be mapped onto the corresponding 3D content and employs marker-based detection in the form of frame marker for the augmentation part of the system that is used extensively. To make up the system, three (3) core use cases are generated as follows:
  A. Marker Registration and Detection-*Using 'frame marker' in Qualcomm AR library*
  B. Texture Extraction and Processing- *Using computer vision library OpenCV*
  C. Texture Mapping-*Done using UV mapping*

- ***GeoAR*** is an interactive book that implements augmented reality to support learning geometry topics. The software targets elementary school students and aims to engage and motivate them while helping them learn new topics. A prototype was then generated which included different features such as animation, 2D images and sounds. Developers and teachers evaluated the software and then an improved prototype was generated and evaluated by students. Finally, the functionalities of the interactive book were specified which include a guidance to use the software alongside the book.

- **Magic Book**, which signifies collaboration between physical object, augmented reality and immersive virtual space. It uses handheld augmented reality display to reflect 3D scenes appearing out of the pages of the book. Also, as multiple readers can see the book at the same time, multiple users will be able to immerse into the same virtual scene simultaneously, each with different handheld device connected to the network. Different users will be represented as virtual characters in the virtual space and will be able to identify one another in the same space.

- ***CAViAR*** is an iOS application, which supports augmented reality, indoor localization and navigation. It aims to provide intelligent campus environment where users can move around campus and find different rooms and facilities easily. The application draws optimal routes from current location to the desired destination as well as provides clickable virtual buttons for viewing information about different locations.

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- ***The TineMelk*** AR App is an augmented reality application for advertisement in Norway. The application is implemented for both Android and iOS operating systems using Vuforia SDK. A QR code is printed on over 50 million milk cartoon to help the user install the AR app and start the AR experience. The user will be able to view two talking cows in a farm scene around the physical milk cartoon, one of them is reading information from the carton while the other detects the user and they stop talking.

2.1.2 Pitfalls in existing system

1. The image of the object has to capture first and then the model is created so does not happen in real time.
2. The system uses a marker based image recognition technique for detection
3. Most of the systems do not support text recognition which is the most important for creating AR Books.
4. The system are not made or intended for an educational purpose.
5. The system are developed on native android and hence are not compatible with other platforms.

Our system plans to overcome these pitfalls by firstly making the camera module dynamic i.e there would be no need to take capture an image. Also, it will not only include image recognition using markers, but also include markerless image and text recognition. Lastly, our system will be platform independent and could be run on multiple operating systems.

Chapter 3

Proposed Solution

3.1 Draft of Proposal

After a research on technologies available to serve the purpose, unity 3d and vuforia were selected to be used for implementing the project.
The system should be able to

- detect and track markers in real time on a mobile device for augmentation
- allow for interaction with the augmented models
- supported on multiple devices and be cross platform
- work with marker or markerless images
- be free for download and usage for everyone

To be able to comply with the requirements and stay within the time constraint of the project, the choice was to use a complete AR system for the implementation. Using such a system means that detection, tracking, modelling and rendering can be managed all together. The chosen system for the implementation was Qualcomm's Vuforia together with Unity3D as, the rendering and visualization component.

3.2 Architecture of Proposed System

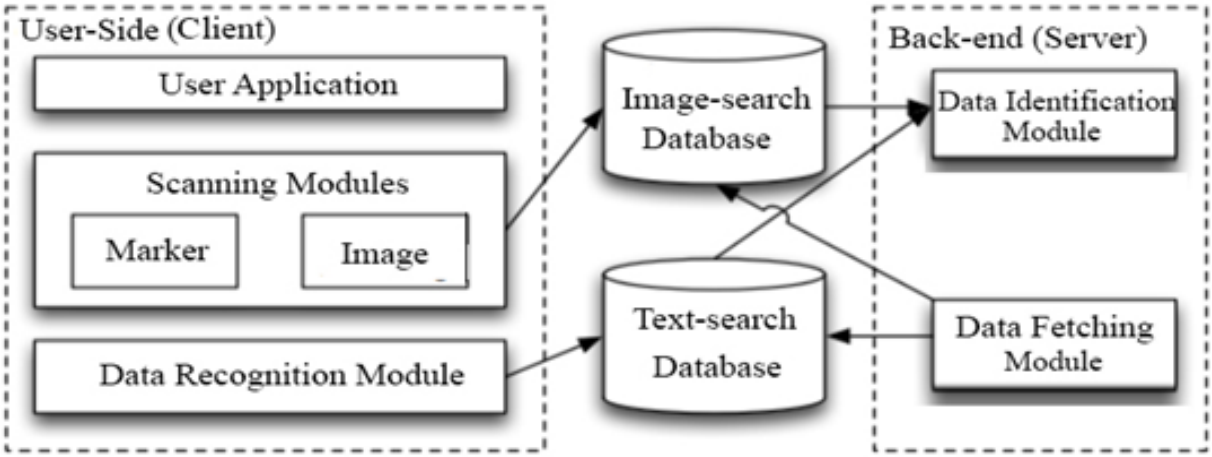

Figure 3: Architecture of Proposed System

The architecture of our proposed system is a client-server architecture. It is selected as it adequately satisfies the requirements of our project such as having a client application for the users and a back-end database which can be used to render the graphics and models from the database. A data identification and a fetching module runs in the background while image search and text search for data recognition takes place at the client side.

3.3 Modules and subsystems

The system consists of multiple modules which are interdependent on each other for the overall functioning of the system. These modules range from camera initialization to content identification and rendering of graphics from the database.

3.3.1 Marker detection

The detection method will depend on the design of the marker. Square markers are detected searching for lines and contours while circular markers are detected searching for blobs. One contour detection algorithm for square markers that takes advantage of the fact that the markers are four-sided quads with a black border.

If the detected lines are contours, or if they belong to a quad, they are stored as marker candidates together with their corresponding corners. To keep the algorithms as low-cost as possible a fast rejection/acceptance test is often followed by the detection to ignore obvious non-markers. The test can be done in various ways e.g. defining a minimum and maximum accepted size of the marker, checking how gradients change along a direction, counting holes in the marker or checking if the numbers of points describing the contour are more or less than four. If a candidate fulfills the requirements, it is stored as a marker. Example, if we want to detect the word 'Resistor', the marker which is nothing but this word will be detected first.

3.3.2 Text Recognition

The Text Recognition feature allows developers to create apps that detect and track printed English words. The words are matched to a defined list of words. The developer can build a user experience by handling text recognition events. Vuforia can detect words that belong to a pre-defined word list. The SDK provides a list of 100,000 commonly used English words that can incorporate into Text Recognition apps. Also, one can define custom word lists and filters that block words from being recognized.

E.g. the marker/word 'Resistor' is detected, then a blue box will appear surrounding the word which means that it is recognized.

3.3.3 Image Recognition

Image Targets represent images that the Vuforia SDK can detect and track. Unlike traditional fiducial markers, data matrix codes and QR codes, Image Targets do not need special black and white regions or codes to be recognized. The SDK detects and tracks the features that are naturally found in the image itself by comparing these natural features against a known target resource database. Once the Image Target is detected, the SDK will track the image as long as it is at least partially in the camera's field of view. E.g. just like the image or marker is detected, also the application provides learning from the images on the textbook. This is by the image recognition that the application provides.

3.3.4 Information retrieval from database

After text detection using vuforia sdk information retrieval is done from the database by matching of the keywords. When an appropriate match is found, the application will store the related data and provide it when the image / text is recognized. Each recognized image/text has a corresponding 3D model or video information stored in the database. This stored information is retrieved from the database and then rendered on the screen for the user.

3.4 Features of Proposed System

- The system is platform independent as it can be deployed on any operating system.
- The proposed system makes learning via books much more interesting and interactive.
- The system supports identification of both marker and markerless images.
- Along with images, even textual data is been identified using various text recognition techniques.

Chapter 4

Project Management

Project management is the discipline of planning, organizing, securing and managing resources to achieve specific goals. The Project was broken down into various modules based on functionalities to be delivered. For each module, requirements gathering, analysis and research on implementation was carried out. The time required for execution of each module was estimated and planned accordingly. Deadline for each module was scheduled and met.

4.1 Schedule

The time required to develop the tool was estimated based on various phases of software development lifecycle. Schedule for the various phases is shown in Table 1 and the various activities performed during the tool development are shown in Figure 5.

Tasks	Duration
Requirement Elicitation	10
Requirement Analysis	12
Software Requirement Specification Preparation	15
Project Plan	6
Software Design Specification	11
Module Analysis and Design	9
Design Approval	5
Implementation	60
Unit Testing	10
System Integration Testing	9
Refinements	5

Table 1: Schedule

4.1.1 Task Network

Task network is used to represent the flow of all task's carried out during the project.

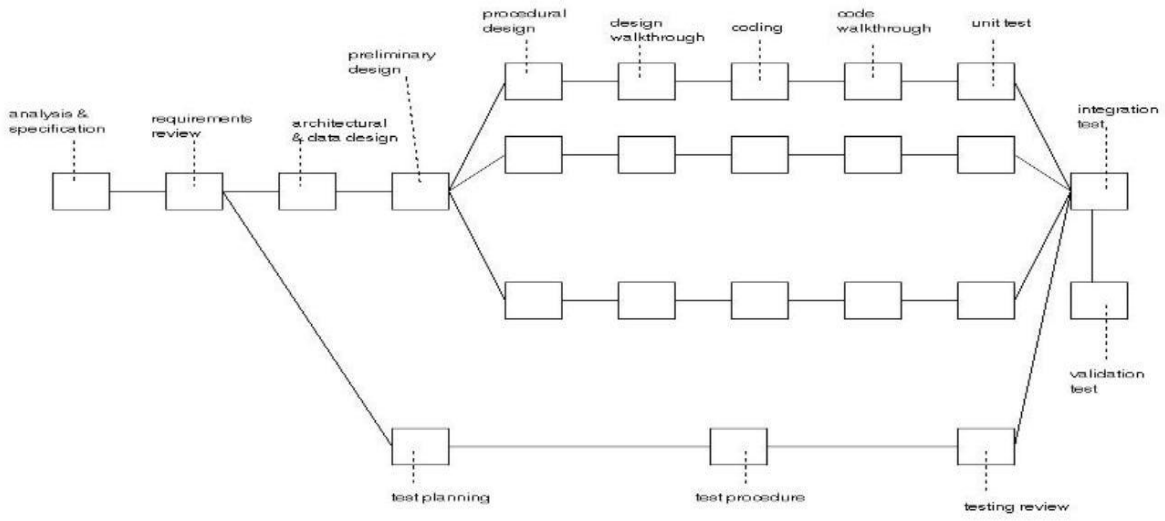

Figure 4: Task Network

4.1.2 Timeline Chart

The figure 7 represents the timeline of the overall project schedule.

Task Name	Duration	Start	Finish	Predecessors
Literature Survey	16 days?	Tue 7/14/15	Tue 8/4/15	
Requirement Elicitation	11 days?	Thu 7/30/15	Thu 8/13/15	
Requirement Analysis	18 days	Fri 8/14/15	Tue 9/8/15	2
Analyzing Related Papers	11 days?	Wed 9/9/15	Wed 9/23/15	3
SRS Preparation	6 days?	Tue 9/22/15	Tue 9/29/15	
Project Plan	8 days?	Wed 9/30/15	Thu 10/8/15	5
Software Design Specification	7 days?	Fri 10/9/15	Fri 10/16/15	6
Module Analysis and Design	7 days?	Tue 10/13/15	Tue 10/20/15	
Design Approval	3 days?	Wed 10/21/15	Fri 10/23/15	8
Implementation	51 days?	Fri 12/18/15	Fri 2/26/16	
Unit Testing	11 days?	Tue 3/1/16	Tue 3/15/16	10
System Integration Testing	8 days?	Wed 3/16/16	Fri 3/25/16	11
Refinements	6 days?	Tue 3/29/16	Tue 4/5/16	12
Project Report	7 days?	Wed 4/6/16	Thu 4/14/16	13

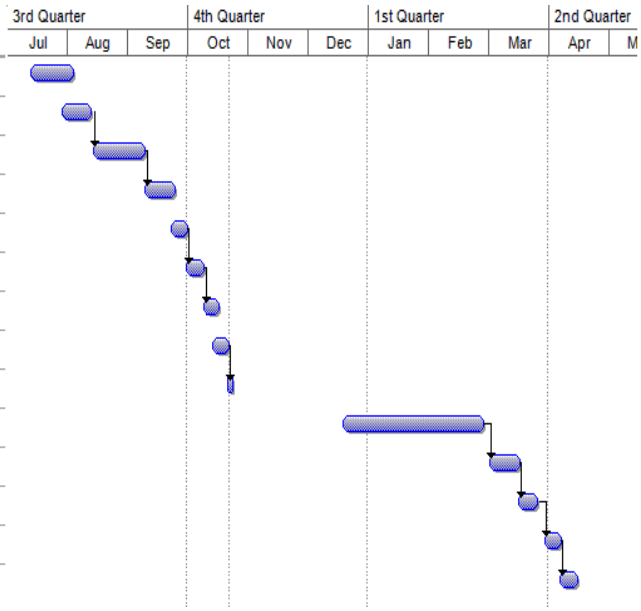

Figure 5: Gantt chart

4.2 Feasibility Study

This section talks about the technical, operational and economic feasibility in detail.

4.2.1 Technical Feasibility:

Technological Frameworks: To be able to comply with the requirements and stay within the time constraint of the project, the choice was to use a complete AR system for the implementation. Using such a system means that detection, tracking, modelling and rendering can be managed all together. The chosen system for the implementation was Qualcomm's Vuforia together with Unity3D as the rendering and visualization component.

Database: The primary data storage system will be MySQL based. The query language used will SQL. All these technologies are tested as should serve the purpose efficiently.

Scalability: The above technology stack used is scalable and extensible as per the needs. This ensures that we have the necessary capacity to handle the solution.

Platform Independent: As there are multiple mobile platforms available, our system can be easily be deployed on any platform.

4.2.2 Operational Feasibility:

Time: The current mode of operation provides adequate throughput and response time. It can be further improved with some tweaks and optimizations. The system provides dynamic results rather than image capture thus saving time.

Cost-effective: Present operational mode is quite cost-effective as it is based on open-source technologies and thus saves a lot on licenses and subscription fees.

Use of resources: Maximum resources such as mare used in the current mode and includes adequate people and time to complete the task.

Flexible: The current flow of work is quite flexible and expandable taking care of unforeseen problems and that might arise later in the project due to insufficient resource planning or managing.

It is flexible because it is platform independent and does not require any special features in the smart phone for the application to work.

Management: Various tasks has been assigned to the project members to complete the project in a managed and structured manner.

End-users: A large market is present for the system as people from all backgrounds and interests can utilize it. The system will really benefit the society especially the students and help them understand the concepts easily.

4.2.3 Economic Feasibility:

Cost Effective: The current system is quite cost effective as it mostly depends on technologies and sources, which are free of cost. Present operational mode is quite cost-effective as it is based on open-source technologies and thus saves a lot on licenses and subscription fees

Hardware cost: The entire server stack can be moved on to the cloud thus saving a lot on hardware costs. We only need to pay as per our usage, which greatly reduces the initial investment. Software development costs: All the necessary software required to implement the solution are freeware and open-source alternatives are available for the expensive ones. Thus, the cost is drastically reduced by moving on to free software.

4.3 Project Resources

4.3.1 Hardware requirements:

For Windows Application:

- Processor: Intel i5® Core TM 16 CPU
- System Bus: 32-Bit.
- RAM: 3.5GB of RAM
- Hard drive: 50GB
- Display: SVGA color

For Smart phone application:

- Smart phone with a functioning and minimum 4 megapixel camera.

4.3.2 Software requirements

- **Unity 3D:** This software is extensively used for marker recognition and for deploying to multiple mobile platforms.
- ***Vuforia :*** This is the main library which is used for marker and image recognition.

4.3.3 Operating Environment

- The application needs to be hosted on a Linux based server.
- The Web UI can be accessed from anywhere using the phone application

4.4 Project Estimation

Estimation is basically identifying and acquiring necessary resources such as equipment, materials, man-power etc. required for accomplishing the project successfully. Estimation techniques used for our project are as follows:

4.4.1 COCOMO Estimation Model

Basic COCOMO computes software development effort (and cost) as a function of program size. Program size is expressed in estimated thousands of source lines of code (SLOC, KLOC).

COCOMO applies to three classes of software projects:

- Organic projects - "small" teams with "good" experience working with "less than rigid" requirements
- Semi-detached projects - "medium" teams with mixed experience working with a mix of rigid and less than rigid requirements
- Embedded projects - developed within a set of "tight" constraints. It is also combination of organic and semi-detached projects. (Hardware, software, operational)

Effort Applied (E) = $a_b(KLOC)^{b_b}$ **[person-months]**

Development Time (D) = $c_b(\text{Effort Applied})^{d_b}$ **[months]**

People required (P) = Effort Applied / Development Time **[count]**

where, **KLOC** is the estimated number of delivered lines (expressed in thousands) of code for project. The coefficients a_b, b_b, c_b and d_b are given in the following table:

Software project				
Organic	2.4	1.05	2.5	0.38
Semi-detached	3.0	1.12	2.5	0.35
Embedded	3.6	1.20	2.5	0.32

Table 2: Basic COCOMO

Basic COCOMO is good for quick estimate of software costs. However it does not account for differences in hardware constraints, personnel quality and experience, use of modern tools and techniques, and so on.

Estimates of effort, cost and duration

Effort Applied (E) = $a_b(KLOC)^{b_b}$ = $3.0*7^{1.12}$ = 26.5235

Development Time (D) = $c_b(E)^{d_b}$ = $2.5*26.5235^{0.35}$ = 7.8743

People required (P) = E/D = 26.5235/7.8743 = 3

4.4.2 Function Point Analysis

Function point metrics, measure functionality from the user's point of view, that is, on the basis of what the user requests and receives in return. Finally, they have decided to focus on five types of components:

External Input (EI): An EI processes data or control information that comes from outside the application's boundary. The EI smallest unit of activity that is meaningful to the end user.

External Output (EO): An EO is an elementary process that generates data or control information sent outside the application's boundary

External Inquiry (EQ): An EQ is an elementary process made up of an input-output combination that results in data retrieval

Internal Logical File (ILF): a user identifiable group of logically related data or control information maintained within the boundary of the application

External Interface File (EIF): a user identifiable group of logically related data or control information referenced by the application, but maintained within the boundary of another application. This means that EIF counted for an application, must be an ILF in another application.

Let us predict every functions complexity is low, so the values can be presented in a table:

Category	Multiplier	Weight
EI	4	3
EQ	4	4
EQ	3	3
EIF	4	7
ILF	4	7

Table 3: Function Point Analysis

(4*3) + (4*4) + (3*3) + (4*7) = 93 [Function Points]
Let us omit additional technical complexity factors, so the only thing left to do is to check how long it takes to produce 65 functional points. Then, the last thing is:

93*5=465 [hours]

The estimate for developing the product would take about 465 hours of work.
On an average, each member has around 116 hours of work.

4.5 Risk Management Mitigation Planning

Risk	Category	Probability	Impact
Insufficient Processing Capability	PS	High	1
Deviation from software engineering standards	BU	Low	3

Table 4: Risk Mitigation

Impact Values:

1 – Catastrophic
2 – Critical
3 – Marginal
4 – Negligible

A project team begins by listing all risks in first column of table. Each risk is categorized in the second column (PS-Project Risk, DE-Development Risk, BU-Business Risk, and TE-Technical Risk). The probability of occurrence of each risk is entered in the next column of the table.

Chapter 5

Project Design

Project design includes an array of activities from generating ideas to planning how these ideas could become a realizable project. It basically represents a blueprint for the project. For which research papers were studied and requirements were gathered. Analysis and research over the requirements were carried out and refinements were made. After successfully completing the requirements phase, implementation phase was commenced. Various obstacles were encountered during implementation, but were tackled appropriately.

5.1 Data Flow Diagram

5.1.1 Following figure represents level 0 Data Flow diagram for the system

Figure 6: Level 0 Data Flow Diagram

5.1.2. Following figure represents level 1 Data Flow diagram for the system

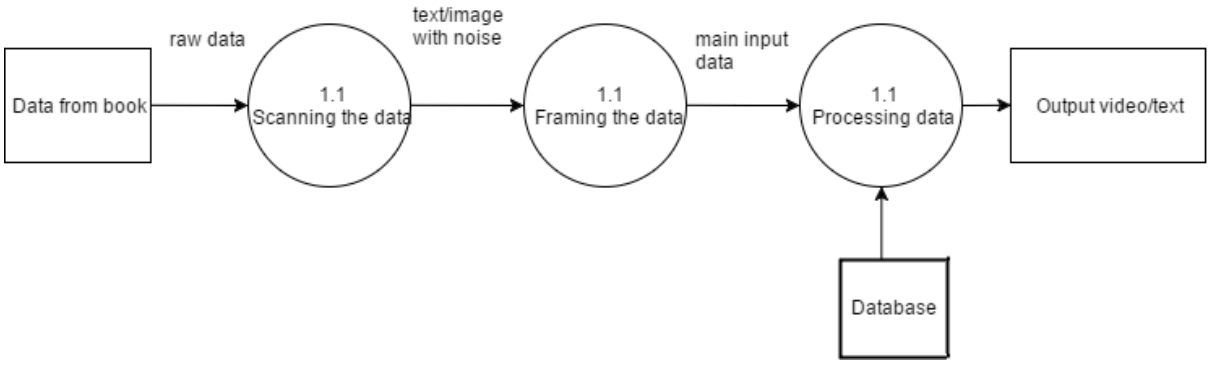

Figure 7: Level 1 Data Flow Diagram

5.1.3 Following figure represents level 2 Data Flow diagram for the system

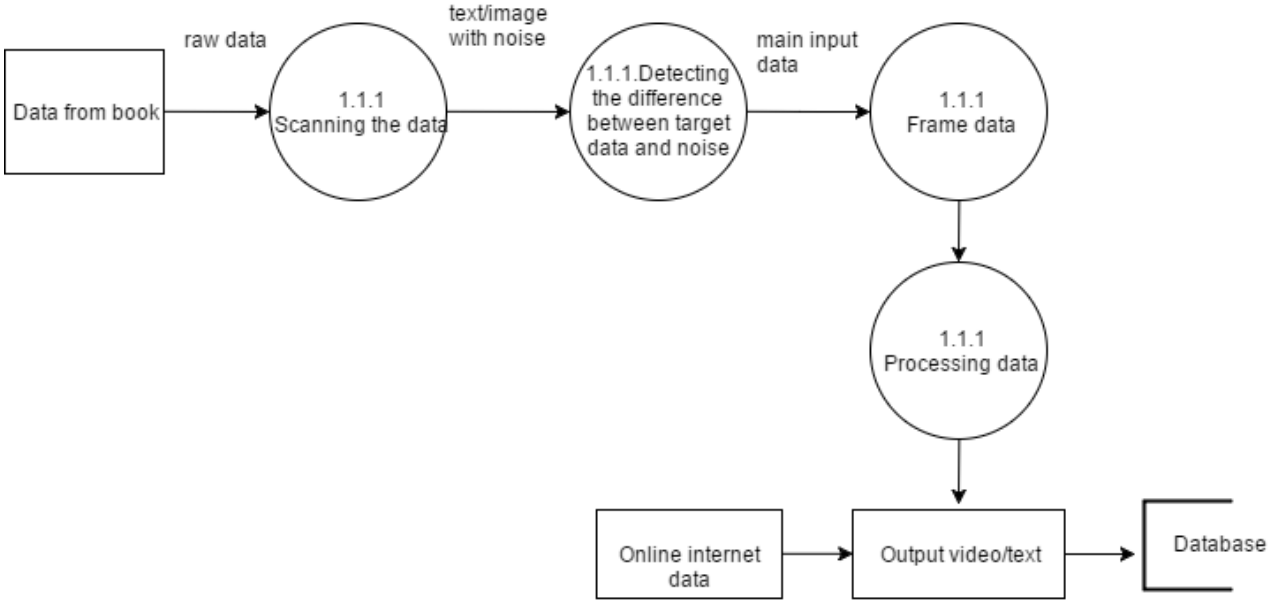

Figure 8: Level 2 Data Flow Diagram

5.2. Flow Diagram

Figure 10 shows the complete flow of every process in the augmented reality system.

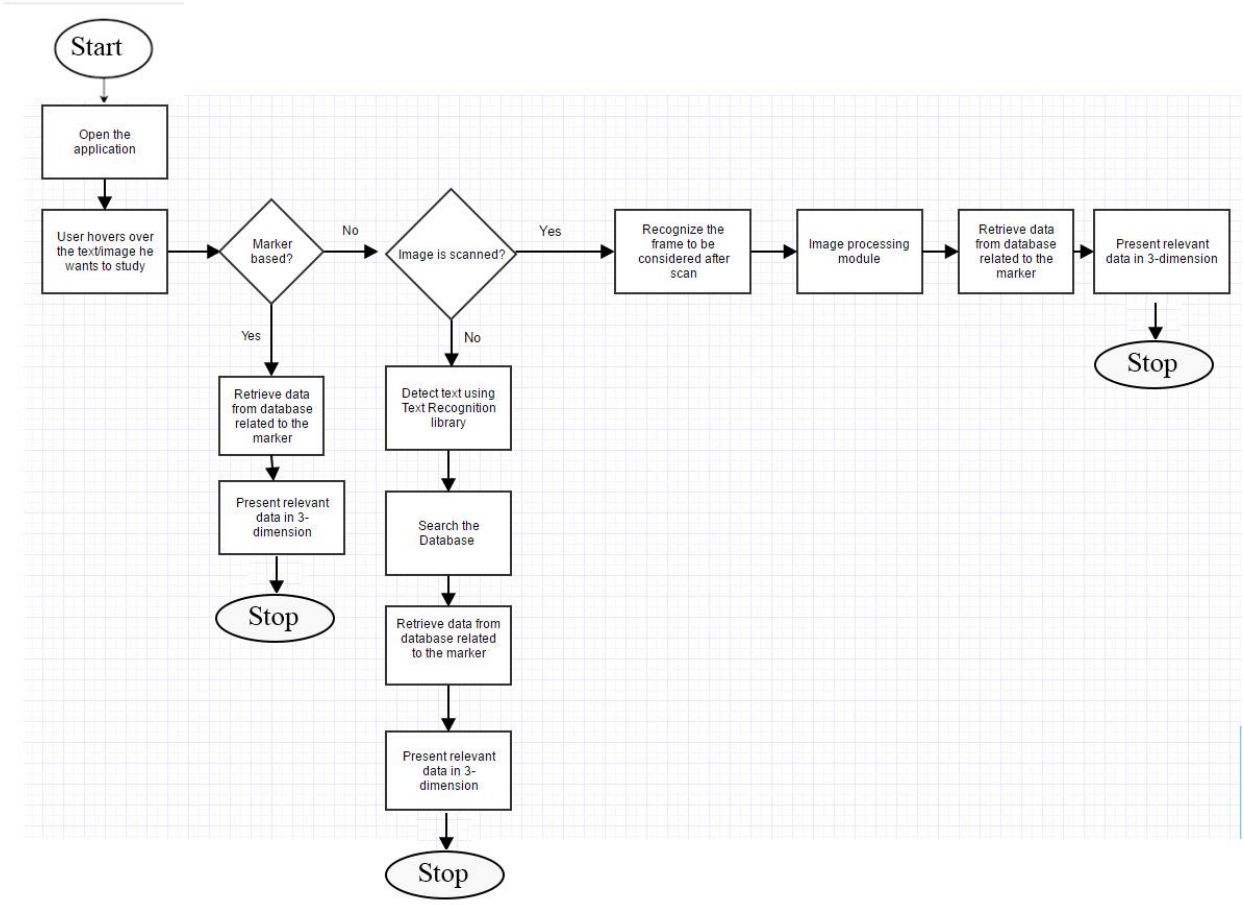

Figure 9: Flow diagram

5.3 Design diagrams (UML)

5.3.1 Use Case Diagram:

Figure 11 shows various actors and their attributes for the augmented reality system.

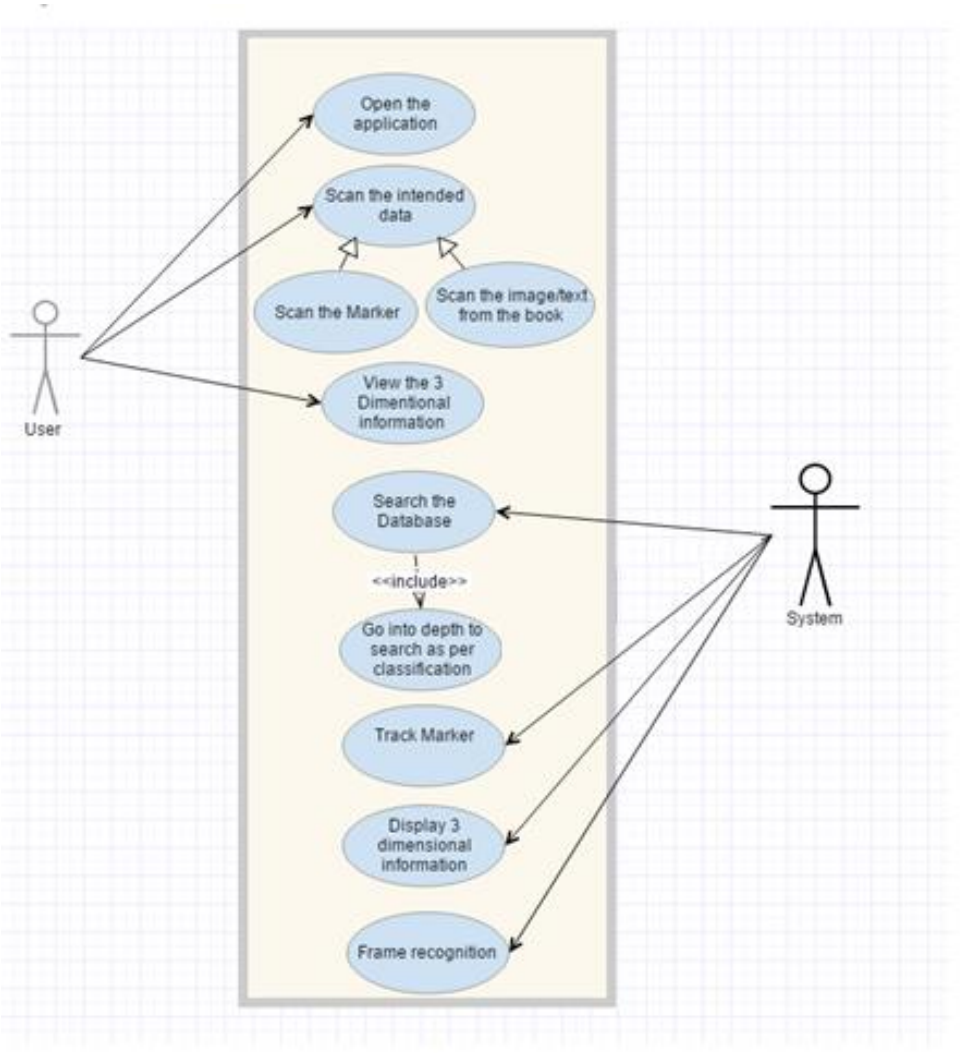

Figure 10: Use Case diagram

5.3.2 Sequence Diagram:

Figure 12 shows the complete sequence of every process through all the phases of augmented reality system.

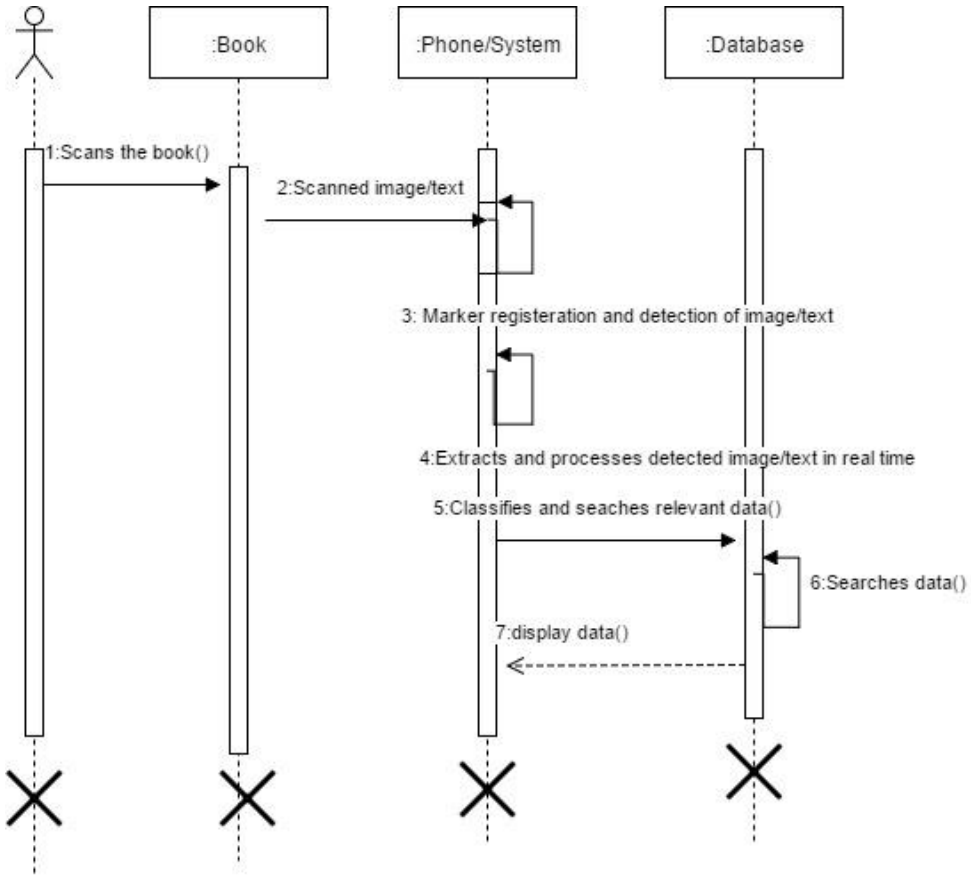

Figure 11: Sequence diagram

Chapter 6

Project Implementation

6.1 System Architecture

After a research on technologies available to serve the purpose, Vuforia library was selected. Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that enables the creation of Augmented Reality applications. It uses Computer Vision technology to recognize and track planar images (Image Targets) and simple 3D objects, such as boxes, in real-time.

This image registration capability enables developers to position and orient virtual objects, such as 3D models and other media, in relation to real world images when these are viewed through the camera of a mobile device. The virtual object then tracks the position and orientation of the image in real-time so that the viewer's perspective on the object corresponds with their perspective on the Image Target, so that it appears that the virtual object is a part of the real world scene.

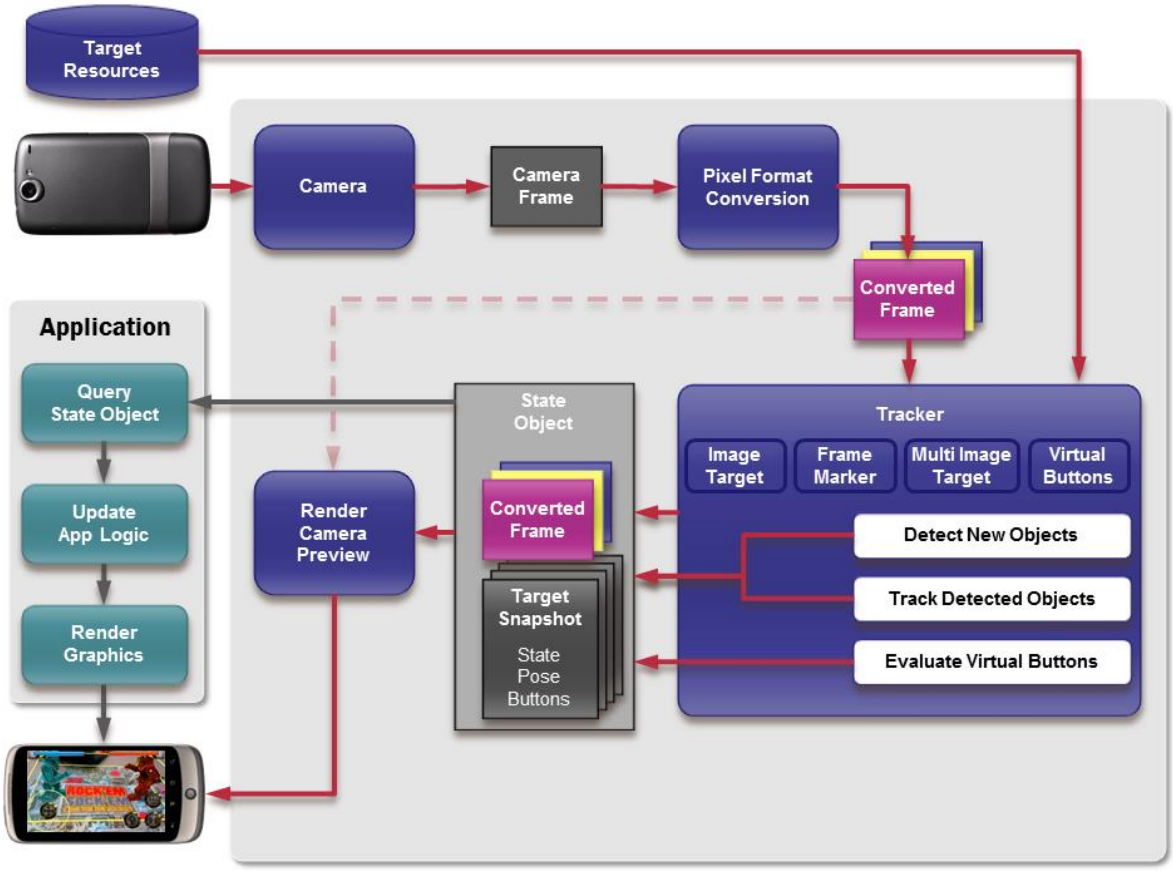

Figure 12:System Architecture

The Vuforia SDK supports a variety of 2D and 3D target types including ‘markerless’ Image Targets, 3D Multi-Target configurations, and a form of addressable Fiduciary Marker known as a Frame Marker. Vuforia provides Application Programming Interfaces (API) in C++, Java, Objective-C++(a language utilizing a combination of C++ and Objective-C syntax), and the .Net languages through an extension to the Unity game engine. In this way, the SDK supports both native development for iOS and Android while also enabling the development of AR applications in Unity that are easily portable to both platforms

6.2 Module Description

6.2.1 Camera Module

This module lets hover over the image of which he/she wants to understand the concept. This module is of prime importance as the data is recognized solely from the camera.

6.2.2 Autofocus Module

This module lets the system to be used with any range of mobile phones. Also, it is a basis for the further text recognition module.

6.2.3 Content Tracking

The camera module is not useful without the content tracker which identifies the required content that is to be tracked and used for augmentation.

6.2.4 Information retrieval from the database

The tracked content is then searched in the database and retrieved on to the system for a user experience

6.3 Module wise Pseudocode

Pseudo-code for Camera Focus

```
using UnityEngine;
using System.Collections;
using Vuforia;

public class CameraFocusController : MonoBehaviour {

   private bool mVuforiaStarted = false;

   void Start ()
   {
      VuforiaARController vuforia = VuforiaARController.Instance;

      if (vuforia != null)
         vuforia.RegisterVuforiaStartedCallback(StartAfterVuforia);
   }

   private void StartAfterVuforia()
   {
      mVuforiaStarted = true;
      SetAutofocus();
   }


   private void SetAutofocus()
   {
      if
(CameraDevice.Instance.SetFocusMode(CameraDevice.FocusMode.FOCUS_MODE_CONT
INUOUSAUTO))
      {
         Debug.Log("Autofocus set");
      }
      else
      {
         // never actually seen a device that doesn't support this, but just in case
         Debug.Log("this device doesn't support auto focus");
      }
   }
}
```

Pseudo-code for Content Tracker

```
using UnityEngine;
using System.Collections;
using Vuforia;

public class ContentManager : MonoBehaviour, ITrackableEventHandler
{
   void Start ()
   {
      TrackableBehaviour trackableBehaviour =
AugmentationObject.transform.parent.GetComponent<TrackableBehaviour>();
      if (trackableBehaviour)
      {
         trackableBehaviour.RegisterTrackableEventHandler(this);
      }

      ShowObject(false);
   }

   public void OnTrackableStateChanged()
   {
      if (newStatus == TrackableBehaviour.Status.DETECTED ||
         newStatus == TrackableBehaviour.Status.TRACKED ||
         newStatus == TrackableBehaviour.Status.EXTENDED_TRACKED)
      {
         ShowObject(true);
      }
      else
      {
         ShowObject(false);
      }
   }

   public void ShowObject(bool tf)
         // Enable rendering:
      foreach (Renderer component in rendererComponents)
      {
         component.enabled = tf;
      }

   }
   #endregion //PUBLIC_METHODS
}
```

Pseudo-code for Text Recognition

```
public void Start()
   {
      // create the texture for bounding boxes
      mBoundingBoxTexture = new Texture2D(1, 1, TextureFormat.ARGB32, false);
      mBoundingBoxTexture.SetPixel(0, 0, mBBoxColor);
      mBoundingBoxTexture.Apply(false);


      // register for the OnVideoBackgroundConfigChanged event at the VuforiaBehaviour
      VuforiaARController.Instance.RegisterVideoBgEventHandler(this);

      mDisplayedWords = textRecoCanvas ?
textRecoCanvas.GetComponentsInChildren<Text>(true) : new Text[0];
   }
```

Pseudo-code on Word Detection

```
public void OnWordDetected(WordResult wordResult)
   {
      var word = wordResult.Word;
      if (ContainsWord(word))
         Debug.LogError("Word was already detected before!");


      Debug.Log("Text: New word: " + wordResult.Word.StringValue + "(" +
wordResult.Word.ID + ")");
      AddWord(wordResult);
   }
```

Chapter 7

Testing and Results

7.1 Test Plan

Testing is the process which gives us a clear indication of how good or bad the developed system is, and also to what extent the developed system is able to satisfy the purpose and objectives that were envisioned in the most initial state of system development. It is a good practice to start testing a system from its initial stages as it gives a clear view of the progress and help to remove, reduce or correct the faults and errors that might take place in the process. We have adopted the same procedure.

1. ***Design verification or Compliance test*:** These stages of testing have been performed during the development or approval stage of the product, typically on a small sample of units.

2. ***Test Coverage*:** The design verification tests have been performed at the point of reaching every milestone.

3. ***Test Methods*:** For each module, corresponding outputs were checked. For testing each module the output produced from running the code was checked with the test data set.

4. ***Test Responsibility:*** the team members working on their respective features performed the testing of those features. Test responsibilities also include, the data collected and how that data was used and reported.

7.2 Test Cases

Sr. No	Test Case	Expected Result	Observed Result	Pass/Fail
1	Marker Detection	Object should recognizable and be placed the accurate location.	The selected object moves in real time and is placed at the user desired location accurately	Pass
2	Text Recognition	The text should be identified	Text is identified with delay	Pass
3	Image Recognition	The image should be recognized with or without the marker points	The image with marker points are immediately identified while other images take some time	Pass
4	Image recognition failure	The error message should be given to keep phone closer or away	No instruction is been given	Fail
4	Information retrieval from the database	The corresponding 3D Model or data should be retrieved	The data is retrieved as soon as the image or text is identified	Pass

Table 5: Test Cases

7.3 Methods Used

Unit Testing:

Unit testing is a method by which individual units of source code, sets of one or more program modules together with associated control data, usage procedures, and operating procedures, are tested to determine if they are fit for use. In our tool, we considered each module as one unit and tested these units with help of test cases and test plan developed. Unit testing was carried out on each module and on every function within the module. Output of each unit was assessed for accuracy and if found incorrect, appropriate corrections were made.

Integration Testing:

Integration testing is the phase in software testing in which individual software modules are combined and tested as a group. The modules of our tool were integrated together in order to verify that they provide the required functionalities appropriately. The various modules were tested together to check for their accuracy and compatibility. There are two types of integration testing, top-down and bottom-up approach. We used bottom-up approach for this application. This is because we built individual modules initially and then combined and integrated all the modules which is bottom up approach.

System Testing:

System testing of software is testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. In this testing, we tested the system as whole to ensure that it provides the appropriate output as stated in the requirements. Overall performance of the system was also tested simultaneously.

Validation Testing:

Validation testing is the assurance that a product, service, or system meets the needs of the customer and other identified stakeholders. Here, we gave the system various possible inputs that the user might give to the system and tested if it provides correct and expected outputs. In case of any deviation from the expected output, corrective action was taken.

7.4 Results (Screenshot)

1) **Content Identification:** The camera module is the first thing that starts when the system has started. Once it starts, it dynamically searches for content on the page rather than requiring a picture of it. It identifies the images with or without markers and for text recognition, a blue box appears around the identified text.

Figure 13: Content Identification

2) **Model rendering:** Once the required content is identified, its corresponding 3D Model or another data is rendered from the database. This extra augmented information is shown right above the identified text or image or a truly augmented reality experience.

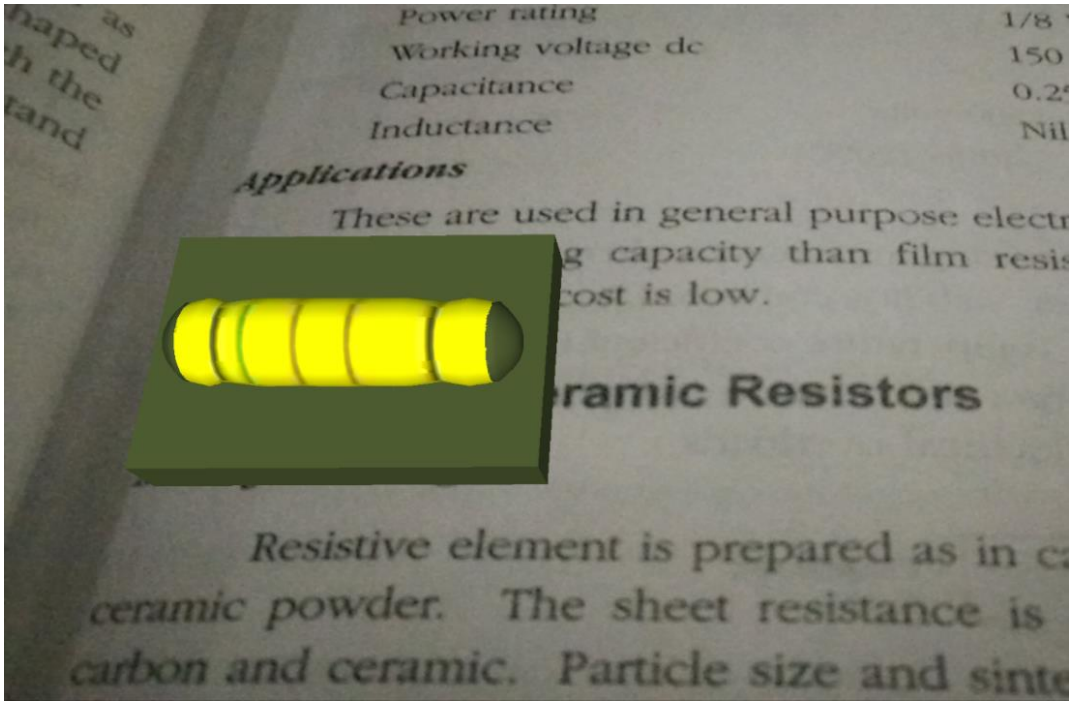

Figure 14: 3D Model Augmentation

3) **Media content shown on hovering:** The content which is first identified is then its corresponding data is rendered from the database. This data can be either of 3D Model or some images or even videos. These videos are played in the system so that can understand the concepts which are tried to explain in a given text or image.

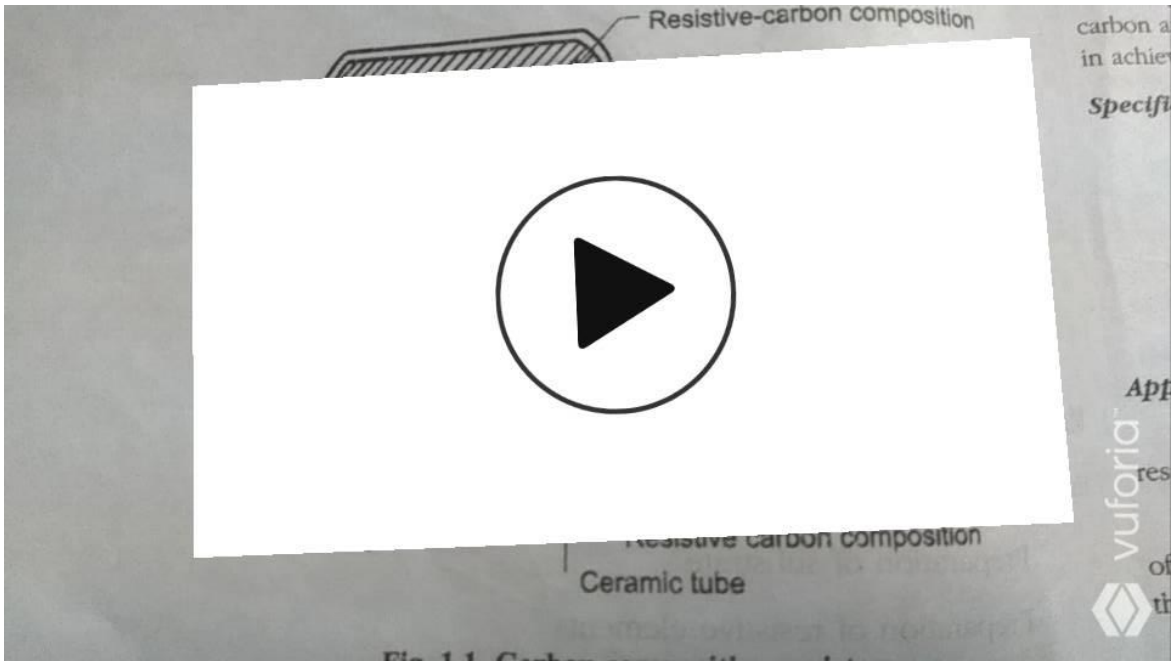

Figure 15: Media Content shown on hovering

4) **The video played with controls:** The video one touched starts inside the player of the system itself. This ensures that the user does not have to switch between multiple apps to view a video. Also, the the video controls are provided by the system itself.

Figure 16: Video played with controls

Chapter 8

Maintenance

Maintenance is basically concerned with the final deliverable of the project. It consists of all the necessary help which can be useful for the user in the initial usage of the application.

8.1 Constrains for use of the product

8.1.1 Mobile Phone with Camera

The most basic requirement for the use is having an Android or iOS device. Since it's a cross platform application, it can be mobile handset that runs on Android or iOS operating systems.

8.1.2 Augmented Reality Book

The Electronics book that is aimed for this project is the need for this project to run. The device will simply be used to scan the intended book and related data will be provided accordingly.

8.1.3 Existing System Support

The mobile phone must be compatible enough to run the Vuforia libraries and thus execute the system. Generally, the system can be easily deployed on an Android, Windows or an iOS device,

Chapter 9

Conclusion

The system **"Interactive Virtual Assistance with Projected Augmentation"** is implemented where a user can hover a camera over a page and obtain augmented information such as 3D Model, video or an explanation about that page. It is a system where no typing or searching is required for getting information. The application provides a helping hand to the children by facilitating them to learn new concepts using graphical aid. Since the application can be deployed on any smartphone, a student can use it as per his/her convenience. Also, there is no need of any extra maintenance for this application thus making it an economical solution. The interactivity aspect of this application like showing the 3D model allows the user to understand the concept from every angle. Also, the video shown with the controls gives the user the exact feel of learning in an actual classroom. The application can be expanded further and used for various age groups for not only learning but also helping the users to visualize and grasp things faster. It provides a unique and interesting way of learning and understanding of unknown concepts.

Chapter 10

Future Scope

It is rightly said that **'Knowledge has a beginning but no end**'. During the implementation of our projects we found that there are instances and scopes where our system can be improved. Following was our observations:

- Apart from its application in the Electronics field, it can be expanded to multiple domains and areas of books
- The media content can be directly accessible from the cloud thus saving the memory of the installed system
- Applications with school books, restaurant menus and newspaper advertising may be performed
- A universal search tool for identifying content dynamically and providing information of it from the Internet can be implemented to make the system truly universal.

Appendix

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