

WanderAR: An Educational Application in Augmented Reality

A Project
Submitted by

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Under the Guidance of

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IN
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At**



**MUKESH PATEL SCHOOL OF TECHNOLOGY
MANAGEMENT AND ENGINEERING, NMIMS, MUMBAI**

MARCH 2020

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Abbreviations

Abbreviation	Description
1. AR	Augmented Reality
2. VR	Virtual Reality
3. MR	Mixed Reality
4. XR	Extended Reality
5. UML	Unified Modeling Language
6. iOS	iPhone Operating System

Abstract

Augmented reality is increasingly reaching young users such as elementary-school and high-school children, as their parents and teachers become aware of the technology and its potential for education. Our inspiration came from the famous fiction novel of Harry Potter where there are photographs that talk. We decided to use a similar approach but in a much more refined sense and for an educational purpose. Traditional classrooms for children are increasingly being replaced by e-learning platforms like Khan Academy. These e-learning platforms, though being interactive, many a times fail to strike a chord with the learner. This is because they tend to be generic instead of catering to individual needs. With Artificial Intelligence learning can be personalized for every child. We intend to create a platform where the system not just responds but also gives its own suggestions to the user when using our platform.

The use of AR is consistently increasing in classroom education as students work together better if they are focused on a common workspace. It not only overcomes the limitations of text based methods but also provides readily available updated information along with virtual environment that connects senses and emotions for an enthralling experience. The application WanderAR aims to educate students of class 3-7 in the subject geography by displaying world heritage sites of different countries and test the acquired knowledge by playing a quiz. It will enhance learning by visual and interactive perception through recognition of images in the real world and presenting additional facts that help view aspects in a different way. This kind of learning through AR can be linked to the self-determination theory which defines learning that occurs through motivation. The virtual learner feels in charge of his/her own learning and can explore various features of the application on its own.

INTRODUCTION

1.1 Project Overview

The project is divided into three main modules. The AR module displays assets in augmented reality and enhances the learning experience. The Quiz module is a general knowledge based game testing the user's knowledge on general facts about each country. The chatbot is a module that can interact with the user as a standalone component whenever the user wants to ask any question and also work with data from the AR module to suggest related information.

The primary motivation behind this project was harnessing the power of AI that is integrated with AR. A user can be motivated to learn if an AR projection is presented over a static informative image but at the same time one is allowed to ask questions, receive answers and gets suggestions and further references to discover more about the piece of information.

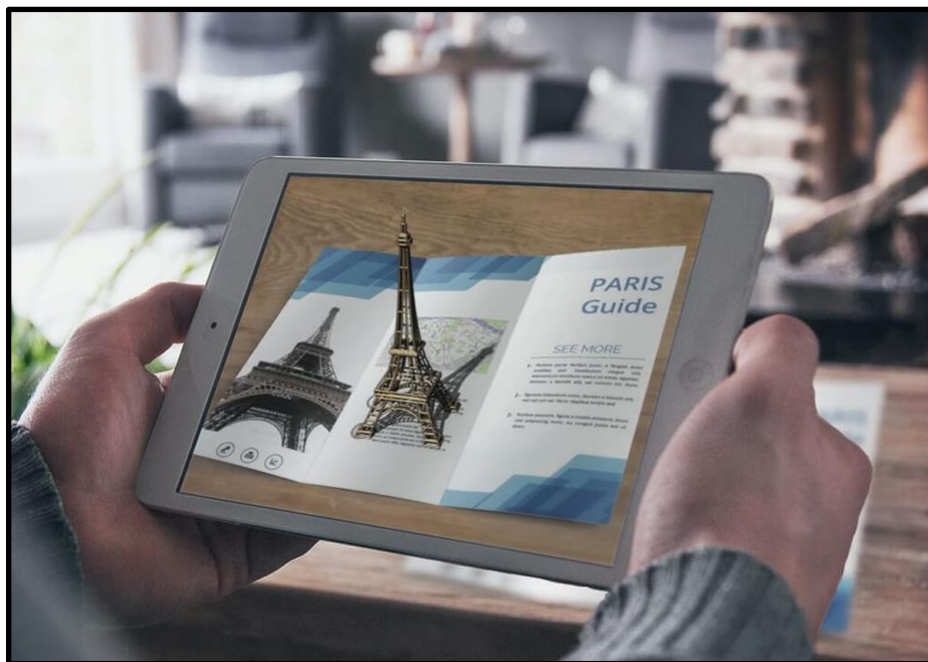


Figure 1.1 A depiction of the project implementation

Our project is concerned with making learning interactive for children through the use of AR and gauge the difference in performance of students in metrics such as reasoning, recall, verbal ability, etc. in AR and non - AR environments with the use of tests or quizzes. We want to create a platform where they will be encouraged to ask questions and receive answers spontaneously through a chatbot. The chatbot will assist students in answering questions based on their understanding and perception. Thus, the interaction will be made more engrossing.

In a nutshell, it will serve to:

- Enhance the learning experience by recognition of images in the real world and presenting additional facts the extended reality
- Educate users of all age groups interested in geography using the inbuilt country encyclopedia
- Participate in quizzes with an intelligent chatbot with option to share knowledge and socialize with others

1.2 Hardware Specification

The hardware components used for this project include three laptops, two of them had Windows OS and one had Mac OS. All three had a RAM of 8GB to enable the simulation of an emulator to run our application. The Windows laptops were of i5 generation – Intel(R) Core(TM) i5-6200U CPU with 2.30GHz to 2.40GHz. The Mac had an Apple GPU (four-core graphics) and its processor was HexaCore (2.65GHz, Dual core, Lightning + 1.8GHz, Quad core, Thunder).

1.3 Requirement Gathering

The following are the project requirements that we identified:

1.4.1 Functional Requirements:

- The system should distinctively recognize the page on which the model is supposed to appear
- After recognizing it should present the 3-d model relevant to the topic
- The chatbot should respond to a range of inputs about the topic accurately
- The 3-d model should be interactive and scalable
- The chatbot should also be able to recommend data about asked input

1.4.2 Non-Functional Requirements:

- The system should be available 24/7
- The system should be accessible on all platforms
- Chatbot should respond within 1-2 seconds
- The quiz in the app should have a secure authentication system and scoring system
- The app should give personalized recommendations of locations

1.4 Scope

1.4.1 Appearance and Performance Level

A key challenge in designing conversational user interfaces is to make the conversation between the user and the system feel natural and human-like. As with many promising technologies, conversational user interfaces enable users to interact with information and communications technology (ICT) using natural language, just like engaging in a conversation with another human being. In human-chatbot interaction, response time can play an important role in how users perceive a chatbot. Generally, it is assumed that very fast responses make a chatbot appear inhuman-like and do not give users the feeling of a natural conversation. In order to increase perceived humanness, many systems with conversational user interfaces use response delays to simulate the time it would take humans to respond to a message. However, delayed responses may also negatively impact user satisfaction, particularly in situations where fast response times are expected, such as in customer service.

The dynamic delay length can be calculated based on the complexity of the response and complexity of the previous message. It is indicated that dynamic response delays not only increase users' perception of humanness and social presence, but also lead to greater satisfaction with the overall chatbot interaction. Building on social response theory, evidence is provided that a chatbot's response time represents a social cue that triggers social responses shaped by social expectations.

1.4.2 Availability

The product is to be developed on the react native platform and will therefore be accessible on both Android and iOS mobile operating systems. There will be no prerequisite installation of libraries or packages to access the product and this serves as a beneficial factor for users accessing it through their cell phones.

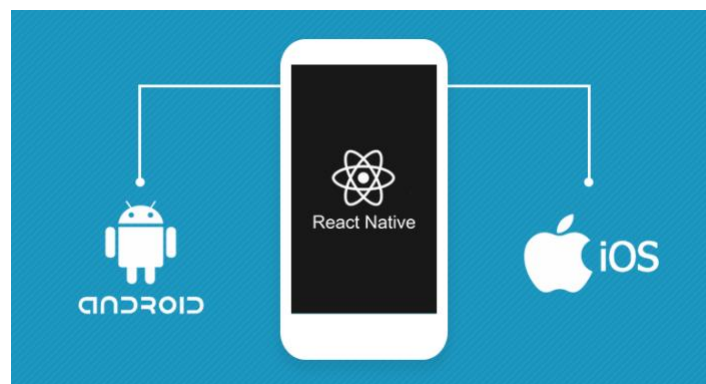


Figure 1.2 Availability of the app Android and iOS

1.4.3 Security

User authentication will be mandatory when accessing the application. If the user allows, the information which the user access in daily life on social media can be linked so as to analyze

interpersonal skills where in the application uses similar form of expression (text or image) to make the user understand accordingly. In this way, different users can get different forms of answers based on their perspective. However, in doing so, there will be no security breach or misleading negativity into users.

REVIEW OF LITERATURE

In our Literature Review we have primarily focused on how to start with our three main project modules. Therefore, our review is divided into three parts, namely- Augmented Reality, Quiz WanderWoman and Chatbot.

2.1 Aumented Reality

Image Recognition

The Cloud Vision API by Google is used for image analysis. For any selected image, the API outputs the image labels, identifies and reads the texts contained in the image and detects the faces within the image. [4]

Our application WanderAR will be using similar machine learning tools to describe the image and where in the world it belongs. For example, an image of Taj Mahal will describe its shape and tell us that it is located in Agra. On further assistance, our application will tell us about its history and recommend similar such historical monuments located nearby such as Humayun's Tomb. For the same, we wish to implement machine learning tools similar to ones used in Google Cloud Vision that filter noise in images and give accurate results.

The research paper evaluates the robustness of the API. It shows that by adding sufficient noise to the image, the API generates completely different outputs for the noisy image, while a human observer would perceive its original content. Distorted images as inputs for training the model result in a drop in the performance of deep convolution neural networks. Thus, the application can readily benefit from noise filtering without the need for updating image analysis algorithms.

Abdalla Mohamed Hambal, Dr. Zhijun Pei Image Noise Reduction and Filtering Techniques

In the second paper the pitfalls of using Google Cloud Vision API are documented. The Google Cloud Vision API is not robust to noise. Hence, we must apply our own noise filtering algorithms to mitigate this issue.

The above thesis describes noise filtering techniques I detail namely high pass and low pass filtering and also describe various advantages and disadvantage of using each of the filtering

techniques. In future we must apply these filtering techniques in our application to make it foolproof and avoid spurious detections and labeling.

We studied the challenges, solutions, and results of implementing AR in a BIM application for both iOS and Android.[6] The application uses native technologies for rendering AR and React-Native for integrating these native implementations in a shared codebase with a uniform UI. This thesis has resulted in an application capable of visualizing and mapping BIM models to real-world buildings using Stream BIM's existing data.

There are multiple ways to create native bindings in react-native. The simplest way to achieve this is to create a wrapper around the application as a UI Component. React-native does not support bindings for Swift, therefore it is required to create an objective-c binding for swift code. As shown in the figure, this is the flow required to implement the component for swift. Steps provided by Facebook can be followed to accomplish this. The API needs to know which project and building to target and from which user. The toggle between AR-mode and 3D is done through a flag. They decided to let react-native handle loading and off-loading of the component, meaning there are only two UI states.

Our application is similarly going to be built using React Native so as to support the operating systems simultaneously and saving time of writing two different codes.

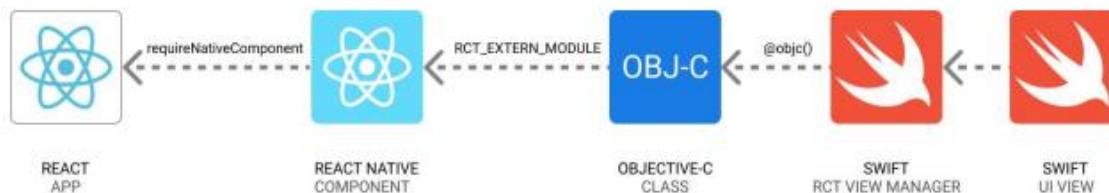


Figure 2.1 React Native UI Component

A separate research presented a mobile augmented reality (MAR) travel guide, named CorfuAR, which supports personalized recommendations.[7] This paper explores the adoption of MAR applications through their emotional impact. A field study on Corfu visitors showed that the functional properties of CorfuAR evoke feelings of pleasure and arousal, which, in turn, influence the behavioural intention of using it. This is the first study that empirically validates the relation between functional system properties, user emotions, and adoption behaviour.

When it comes to interacting with mobile tourism applications, the minimization of cognitive overload is a key design aspect. Functional elements that reinforce positive feelings (e.g. social media features and content provision based on gamification principles) might constitute the optimal design choices.

The paper shows how user emotion impacts the intention of using the application and how to keep users engaged based on their emotions.

We examined the aspects of the Pokémon GO game that influenced travelers to use the app, and to pinpoint features of the mobile augmented reality (MAR) game that can memorably engage with them like a travel guide and influence individual traveler experience during and after usage.[8] This current study specifically focused on examining the behavioral intentions to use the MAR app as a travel guide in the future.

The Pokémon GO app offers all four realms of experiences – educational, entertainment, esthetic and escapist; and enhanced the overall user experience. The observations revealed that a majority (77 per cent) of the respondents would be interested in using Pokémon GO as a travel guide. Furthermore, a majority (73 per cent) of respondents stated that they would be interested in using an MAR game as a travel guide in the future.

It further shows us how destinations are marketed in the tourism industry and how users are spending significant amounts of time just browsing without posting or interacting with others. Thus, we use these observations for our application WanderAR and how it can engage user as a travel guide and influence individual travel experience before and after usage.

2.2 Quiz WanderWoman

To test the effectiveness of our designed UI and what the users remember after using the app, we made a simple game called Wander Woman .It is similar to the game Hangman .But instead of a textual hint we give a visual hint like a flag or a picture .One has to one by one guess each letter of the word displayed on pressing the letter not there in the word the user loses his life .The user has seven such lives . He can even skip the word he is not sure about. The game ends when user either skips the words or guesses them all.

This game through repetition drastically improves the visual memory of the user and also makes it fun user experience. Gaming in general, improves visual attention and spatial-motor skills. It can also develop children's soft skills. They indeed may increase the children's sense of self-esteem and improve socialization skills, leadership skills and team building. It also improves critical thinking and problem-solving skills.

2.3 Chatbot

The first paper that we reviewed presented a review of the technologies that have been being developed to build conversational systems and their special features including language tricks.[1] Only some of the conversational computer systems emerging today in various domains, ranging from hotline support over game environments to educational contexts can pass the Turing test. A

typical chatbot is built based on a knowledge base which comprises a fixed set of input-response templates and a pattern-matching algorithm, a dialogue system typically requires four components: a preprocessing component, a natural language understanding component, a dialog manager, and a response generation component. These components have been compared in various chatbots built over the years.

A notable chatbot called ELIZA built around 50 years back was the first chatbot created and was intended to emulate a psychotherapist. The technology used was pattern matching and keyword searching and it did not pass the Turing test. Over the years, the chatbots built used Parsing, grammatical detection, semantic analysis, Markov chain models, speech recognition and NLP. Cleverscript based on spreadsheets was also used for chatbots. In 2000, AIML was used succeeded by Advanced Pattern Matching and Tokenization. We can notice the tendency of applied technologies for conversational systems are becoming more AI-oriented and deploying more natural language processing technologies.

A high-level conceptual framework for realizing flexible chatbots is founded upon agent-oriented abstractions: goals, plans, and commitments.[2] Commercially available frameworks such as IBM, Facebook, Microsoft, and Google reduce the task of engineering chatbots to a variant of the If-This-Then-That (IFTTT) style of programming that was at the core of expert systems proposed in the 1980s. However, the IFTTT approach is inadequate in terms of the flexibility and maintainability of the chatbots produced. The resulting chatbots all too often are monolithic and they mix rules for managing dialog with rules for executing business logic and generating responses.

Conceptual framework consists of five components with the associated responsibilities: dialog manager (manages natural language dialog with the user); inference engine (extracts user intents); knowledge base (supports inference and planning); planner (produces execution plans); and external services interface (operationalizes plans). To capture a chatbot's internal state and abstract away from its detailed plan, the notion of goals are adopted to model what a chatbot seeks to bring about independently of its actions.

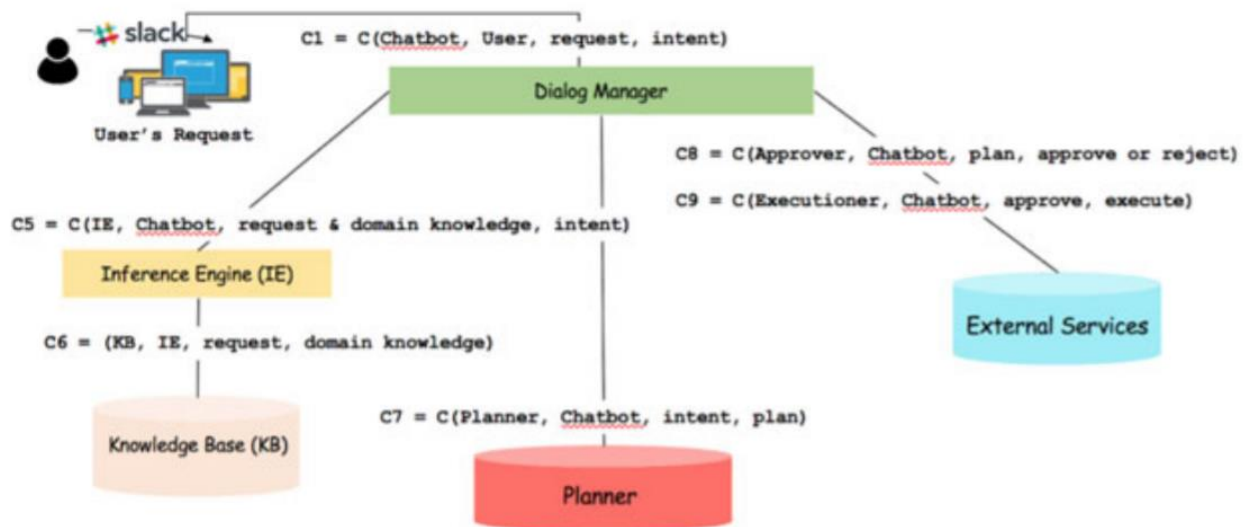


Figure 2.2 Conceptual Framework of Chatbot

We came across a paper that explores how an ‘artbot’ can interact with visitors through chat and convey information about the museum artifacts in the form of short stories. [3] An engaging storytelling approach that is based on direct conversations between the visitors and the characters, places, and items of the exhibition can contribute to building an emotional connection and a deeper understanding of the artifacts and their stories. The aim is to make history a live conversation with artists and artifacts through a chat interface.

The art-bot prompts visitors to ask questions, challenges them to carefully observe artworks and contemplate about artifacts. While these dialogues are mainly used to convey information about the background story of items, parallel stories, in the guise of “small talk,” they are used to expand the agent’s conversational repertoire. The art-bot has its own first-person conversational tone. The immediacy of a first-person narrative gives visitors direct access to the intimate thoughts and feelings of the protagonist, promoting a closer relationship between visitor/guide and subject/character.

ANALYSIS AND DESIGN

3.1 Architecture

In our application WanderAR, we are going to use React Native and Aruco which will act as an interface between the operating system and the application.

There will be three main modules –

- (i) Augmented Reality Module
- (ii) Quiz WanderWoman Module

(iii) Encyclopedia Module

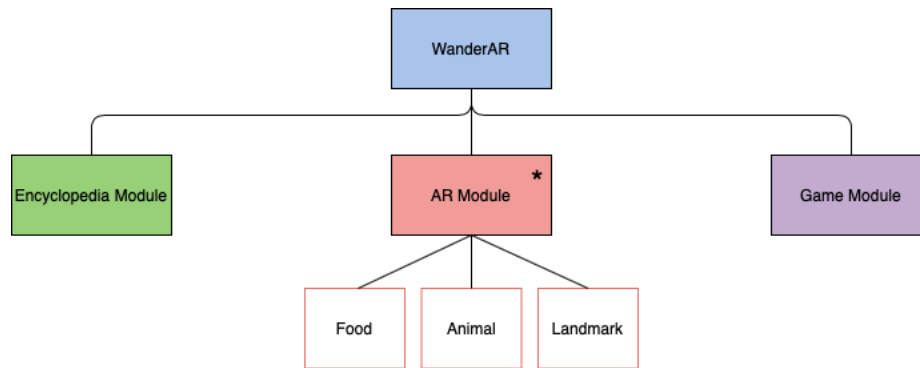


Figure 3.1 A Jackson Structured Diagram of the project architecture

3.2 Design and UML Diagrams

3.2.1 Design of UI

The prototype of the application was designed using Adobe XD. The figures represent the UI design features.

Low Fidelity Prototype:

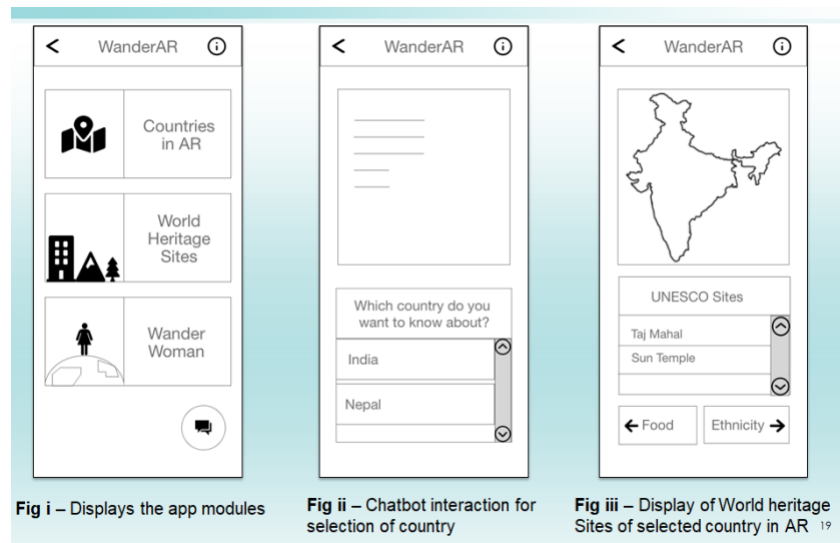


Figure 3.2 UI Design 1

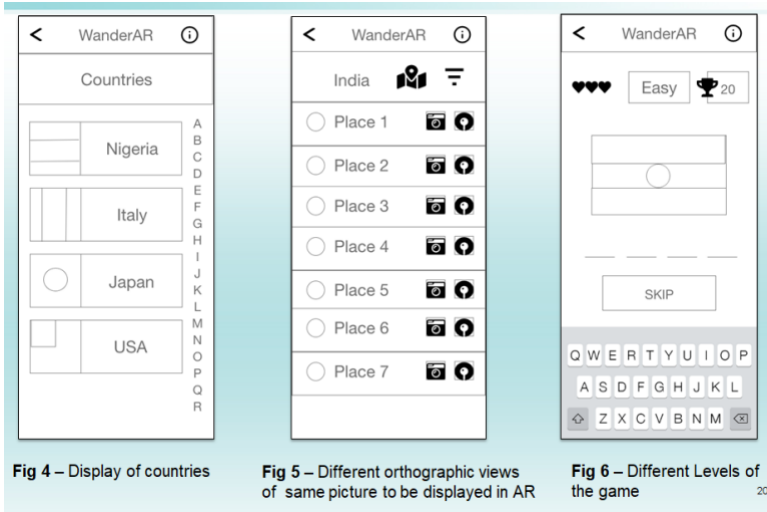


Figure 3.3 UI Design 2

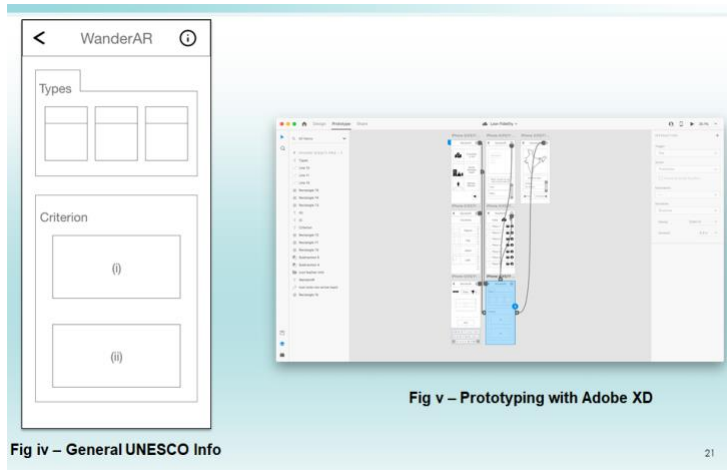


Figure 3.4 UI Design 3

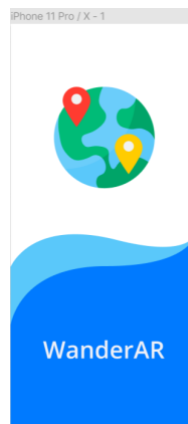
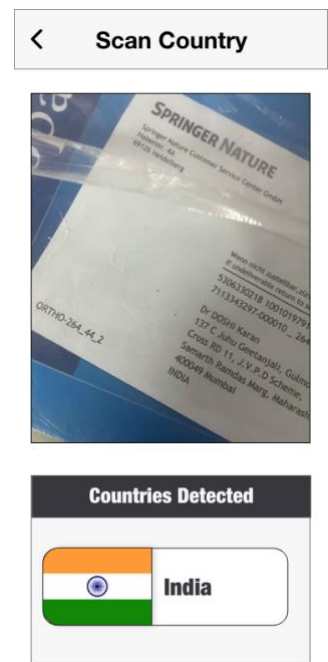
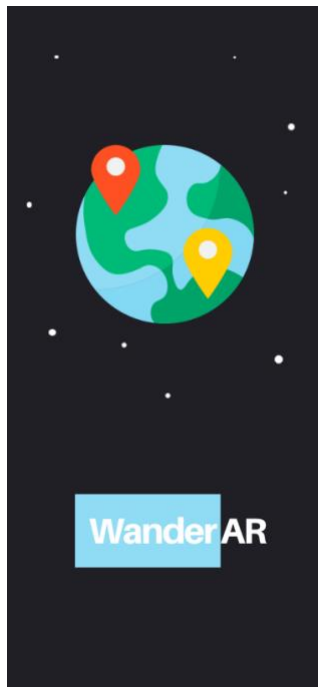


Figure 3.5 Initial Splashscreen Design



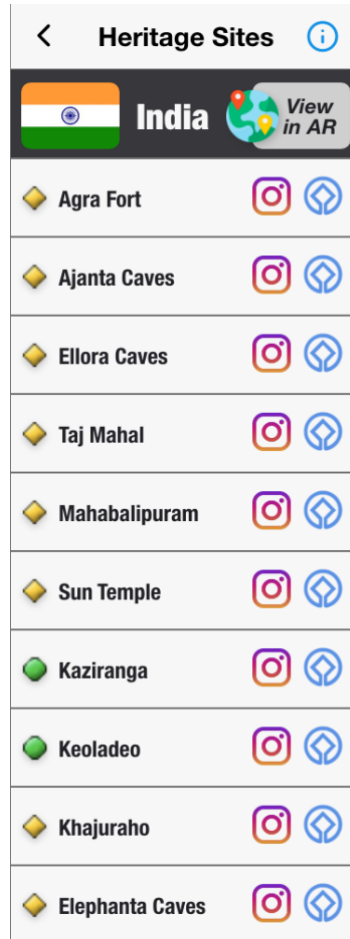
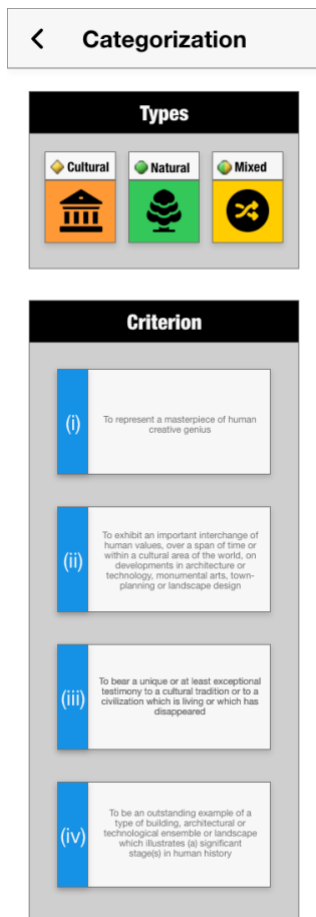


Figure 3.6 High Fidelity Prototype Design

To convert the UI to react native code, we used Zeplin and its React Native extension

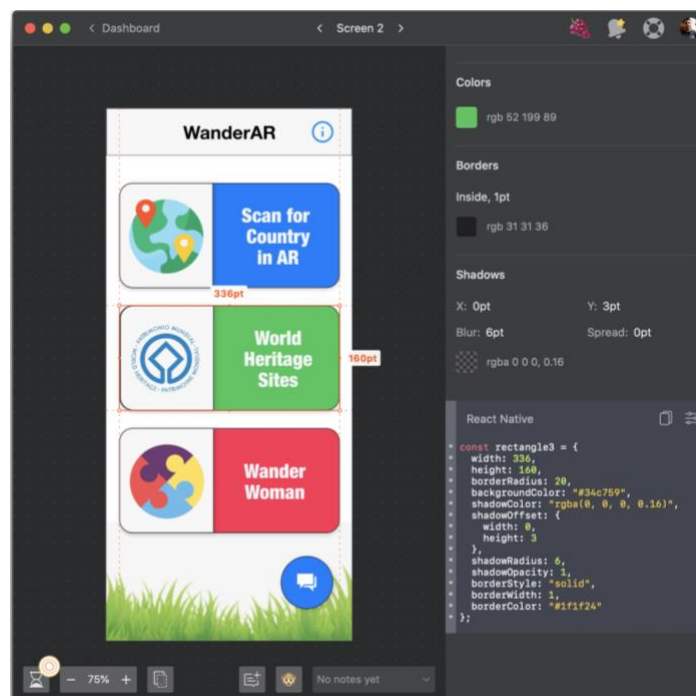
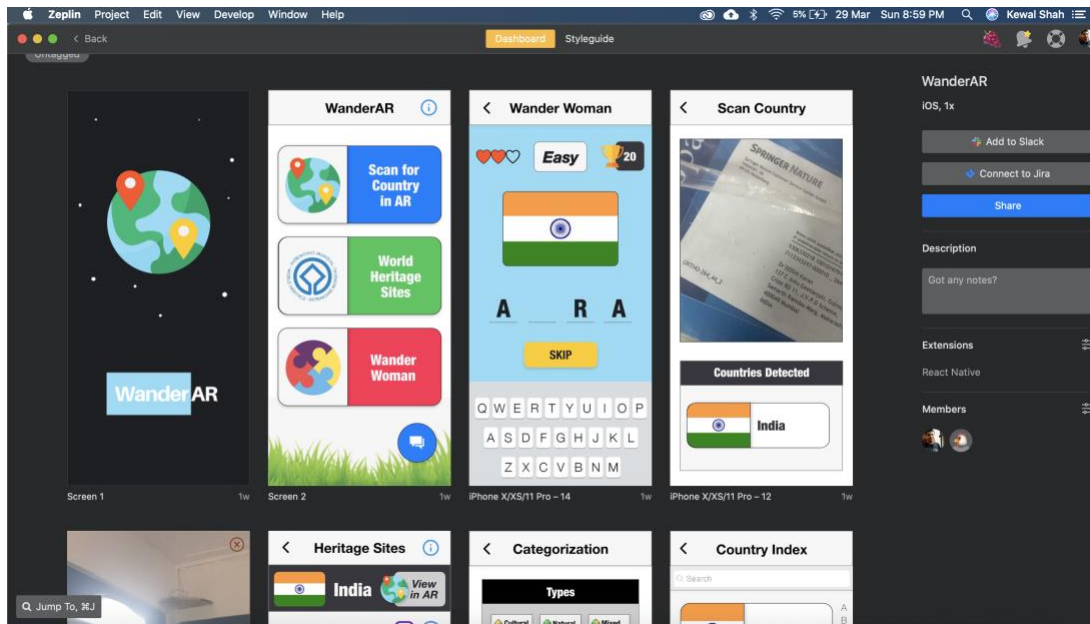


Figure 3.7 Design Handoff using Zeplin

3.2.2 Design of Quiz WanderWoman

An API is created based on the general knowledge questions of each country. The dataset was initially created on an Excel Sheet. The questions are segregated into three levels of difficulty- easy, medium and hard. Refer Appendix.



Figure 3.7 UI Design Quiz Wonderwoman

METHODS IMPLEMENTED

4.1 AR Module

Image Recognition

The image recognition module recognizes the places and objects and then the AR module displays the object and its info. In this iteration of the app we have experimented with Google Cloud Vision API. It offers powerful pre-trained machine learning models through REST and RPC APIs and assigns labels to images and classifies them. It can detect a variety of objects, text, barcodes, etc. If a landmark is detected its location will be displayed using Google Maps along with historical facts and information about the place. The use of an API makes the app lighter as we do not have to train machine learning models and keep them in phone memory. We may in future also train our

own models for better accuracy and speed. Also this API misclassifies the same image with noise. Thus adding noise correction is also required. The disadvantage of using this API is the lack of speed. It takes a lot of time to upload an image from the phone to the internet, severely denting user experience. We use Expo to develop and test the react – native app. Expo is installed in the local development environment. Basically, Expo provides a set of tools to create and publish React Native applications with minimal effort.

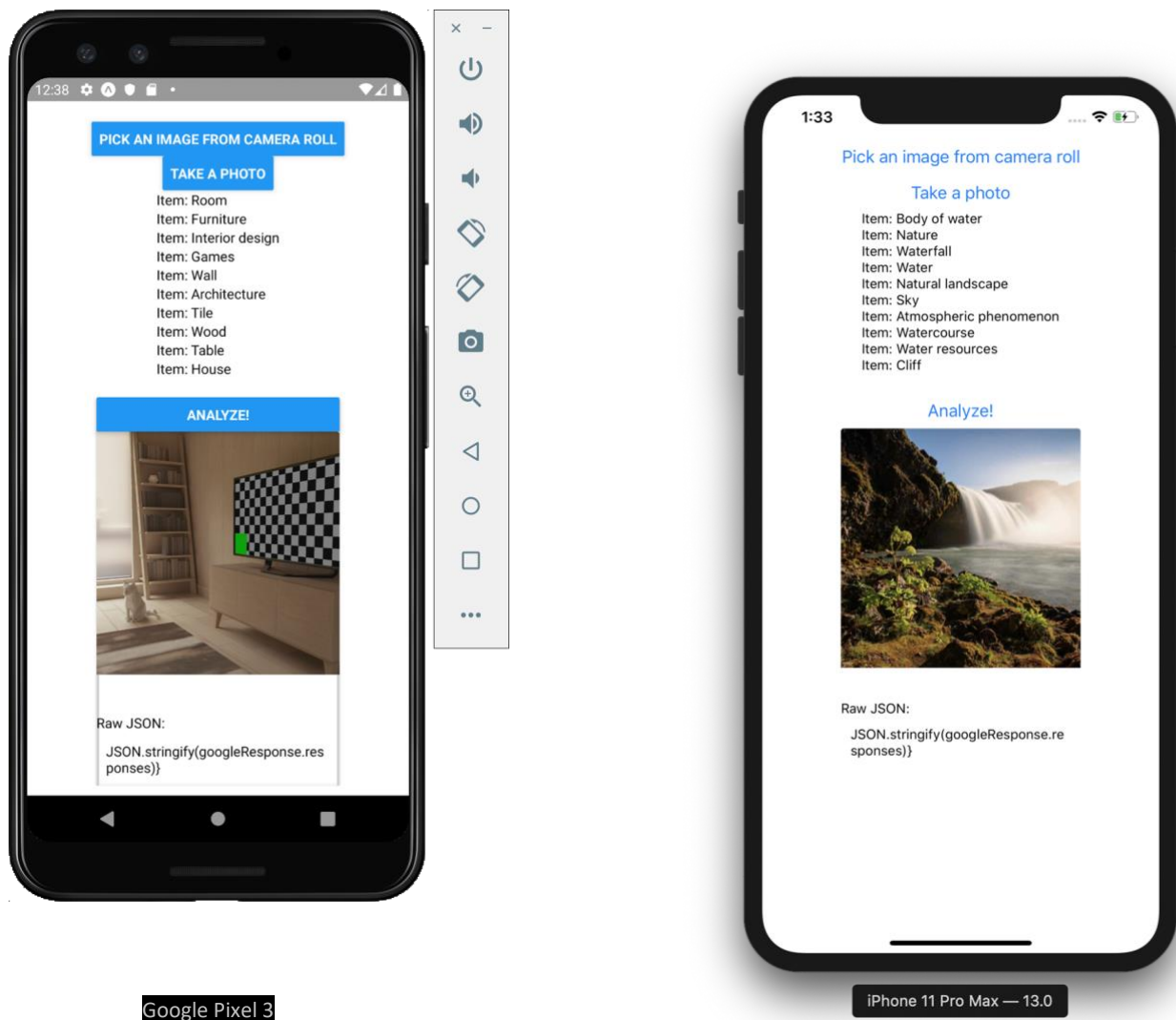


Figure 4.1 Scan Module Implementation in the Android Emulator and the iOS Simulator

The AR module is central to the whole application. In the AR module the object of importance is projected. AR helps the user understand and interact with the places and enhances their ability to remember them.

In the first iteration of development of this particular module we use an AR technology name Vuforia Engine. Vuforia Engine is a software platform for creating Augmented Reality apps. Developers can easily add advanced computer vision functionality to any application, allowing it to recognize images and objects, and interact with spaces in the real world. The positive of this engine is its ability to support a wide range of devices. The negatives are its dependence upon the use of markers and its general lack of power. The use of markers severely hinders our ability to scale and add more places. Instead we decided that markers in our case will be images of the places. This makes things easier for the user since he/she won't have to go through the hassle of locating physical markers and can be at a static place.



Figure 4.2 AR implementation using Vuforia in the first iteration

In the second iteration we used ARCore module developed by Google. Using different APIs, ARCore enables your phone to sense its environment, understand the world and interact with information. Some of the APIs are available across Android and iOS to enable shared AR experiences. ARCore uses three key capabilities: Motion tracking, Environmental understanding and Light estimation. Its positive is enhanced detection of flat surfaces. Its negatives are the lack of support for a lot of devices.

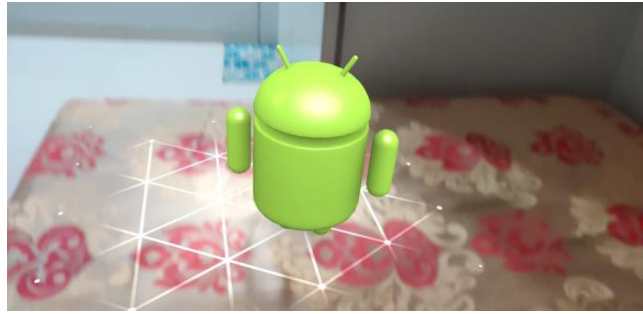


Figure 4.3 AR implementation using ARCore in the second iteration



Figure 4.4 AR implementation in ViroReact

Ejecting Application from Expo to support ViroReact –

Bare React development method required us to separately configure the app settings to support iOS and Android Packages through Xcode and Android Studio and the implementation is complex. Expo is a much easier way to develop React apps with inbuilt libraries but does not support bare React libraries like ViroReact. Our plan is to complete the app development using Expo and then ejecting it to support AR at the end since the process is irreversible

4.2 Quiz WonderWoman Module

The game Wander Woman engages students by guessing the country when a certain fact is displayed on the screen. These questions are segregated into different levels based on which user can estimate its own learning progress. A live APK of these questions has been created and linked to the game. They are general knowledge questions that induce curiosity and lead to further knowledgeable and meaningful discussions when played by a group of students in a classroom. For example, if we consider the country Colombia then questions asked on it will be as follows:

- Easy: Which is the world's leading producer of emeralds?
- Medium: Which country has a river with 5 different colours?
- Hard: Which country broadcasts its national anthem twice a day?

Accordingly, eight letters will be printed on the screen and user can try and test letters with the given amount of tries till the right answer is attained. Before proceeding to the next question, a brief description related to the country will be displayed.

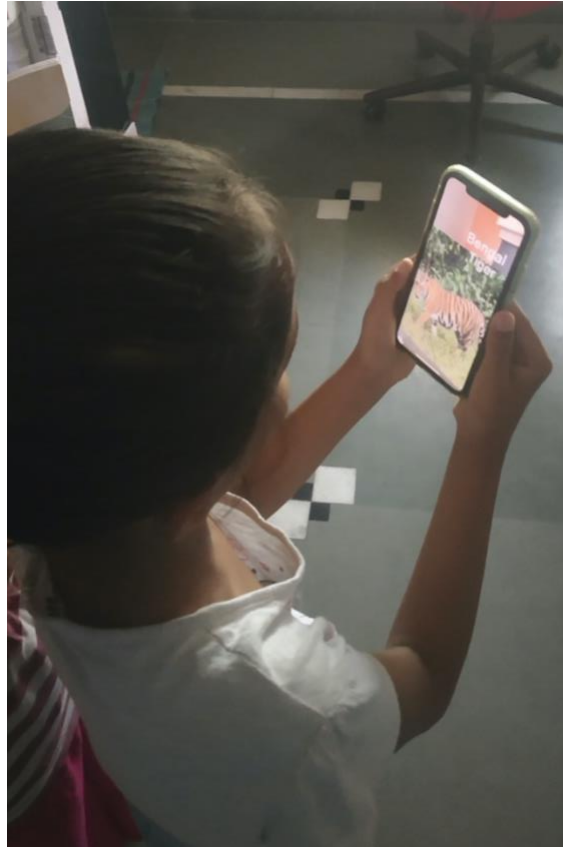
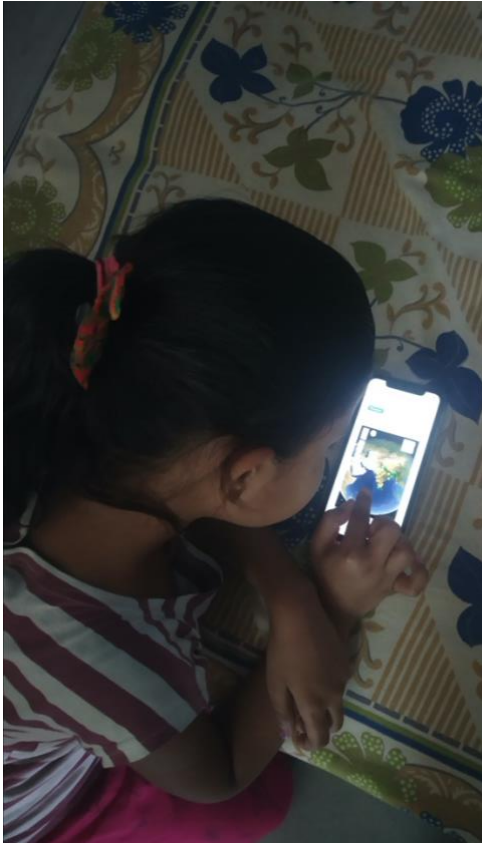
This game tests the memory of the users on guessing the countries cities and place of eminence. It allows the users with lives to guess possible letters in the city name by giving them a hint (flag of the country) and deduct lives if they are wrong. On the correct guess of the entire place user gets a point. In this way, this game can gauge the effectiveness of our design and we can further predict user knowledge through AI.



Figure 4.5 Implementation of Quiz WonderWoman

TESTING

The AR Module the Game and the Encyclopedia module were tested with kids of ages 8 and 9. Although they needed some help with figuring out country names in the game, they loved how the animals appeared in the room with augmented reality,



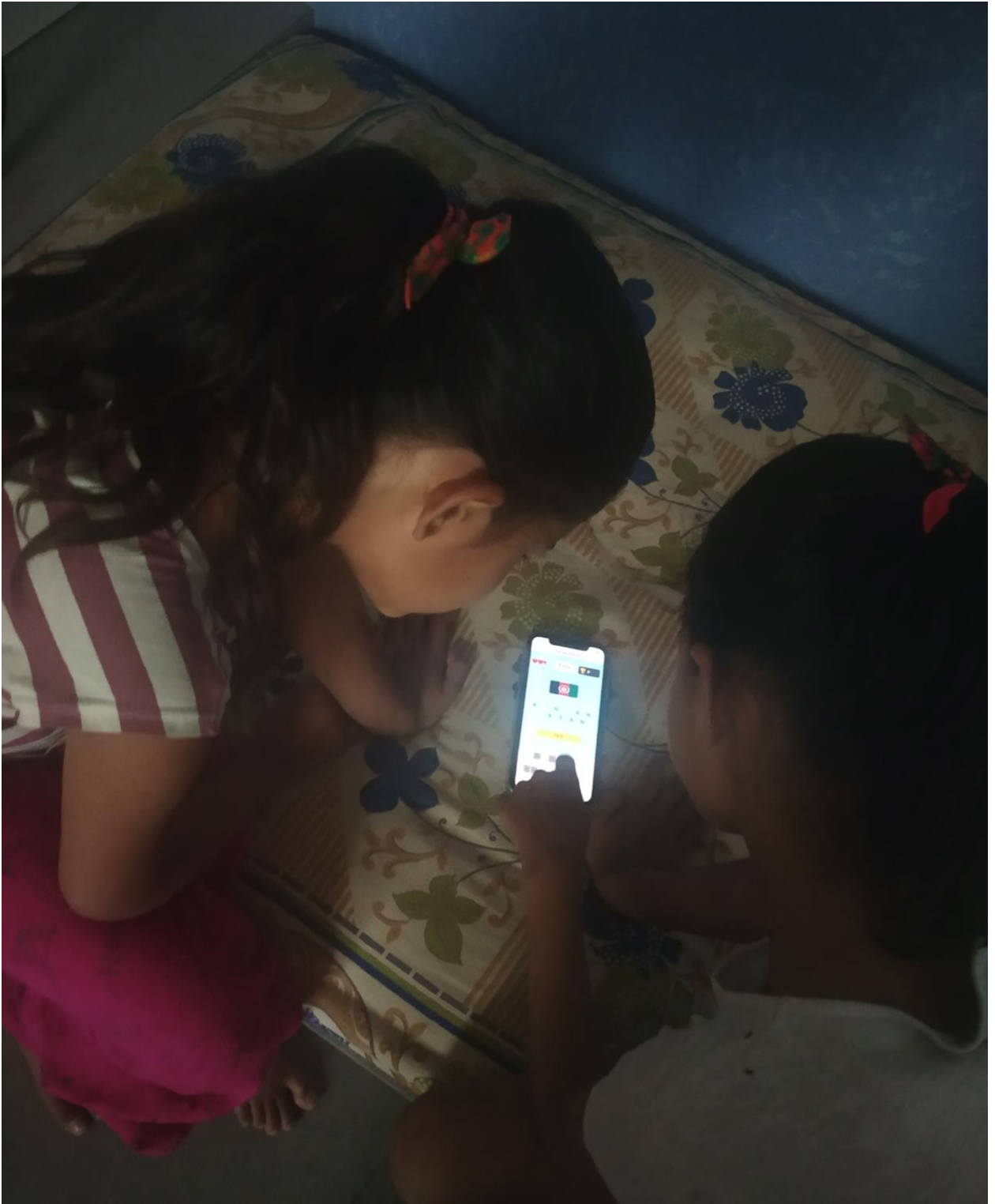


Figure 5.1 Testing the app with kids

RESULTS AND DISCUSSION

Individual modules of our application WanderAR have been implemented. The integration of the modules is still impending. The chatbot module results in a display of dialog box with a greeting message for the user. This is when the user firsts opens the module. This feature can be turned off or on as per user's choice. If the feature is kept on, chatbot will initiate conversations with user based on their places of interest. It will update them with current news of that particular place. It may even provide 'Did You Know' facts, a feature that is integrated with the Encyclopedia Module and user may either read the notification via text through chatbot or view the AR images.

The AR module which was first implemented in the Vuforia Engine did not give efficient results. First, it took a considerable amount of time to load the AR asset. The AR asset that was finally displayed was unstable and disappeared on even slight changes of angles of the device. The ARCore implementation on the other hand detected the plane surface accurately first and then the AR model that was displayed was stable and sharper.

With our image recognition module, we were able to identify primary elements of our image using the Google Cloud API. However, we need to figure out how will we extract specific image information like landmark names from the JSON data. We also might have to integrate Microsoft's Cognitive Services API for recognition of renowned people of a country, a feature that the Cloud Vision API does not support.

FUTURE WORK

We have chosen a bottom up approach to develop our project therefore as of now we have implemented basic versions of the three components, the encyclopedia and the AR module. In the literature review stage, we had also decided to include a Chatbot and have worked on its design and implementation. However as of now its implementation only supports a single country and remains to be integrated. Therefore, the chatbot module will be one of the main features that will be integrated to this project in future.

Design:

The chatbot module consists mainly of five attributes –

- (i) The dialogue manager manages a natural language dialog with a user and interacts with services such as an inference engine, knowledge base, planner, and external

business services to carry out the user's request. The supported user interaction modalities may be text and voice.

- (ii) The inference engine receives requests from the dialog manager and interacts with the knowledge base to infer an appropriate intent based on a user's request. In addition, it may infer entities from the user's request to map them to appropriate actions.
- (iii) The knowledge base represents the chatbot knowledge, including inputs received from a user and about available services and how they relate to the domain. It includes a knowledge graph constituting a set of entities and their relationships, and a set of rules that make inferences based on entities and their relationships. The chatbot designers need to populate the knowledge base with expert knowledge.
- (iv) The planner provides the dialog manager with execution plans for each of its goals. If a plan fails to execute, the dialog manager requests the planner to provide an alternative plan to achieve the goal. In our scenario, to perform the firmware update, the dialog manager requests the planner to create a plan.
- (v) The dialog manager interacts with external services to execute business functions, such as for change request approval, business intelligence service, and remote system management.

Implementation:

Initially, the intent of the chatbot will be specified – User selects countries and countries are classified. For example, all Asian countries, all Eastern countries, all islands. Entities are specified for each country: - History of rulers (dictatorship/ democracy), Culture, Tourist locations, Food, Shopping – what to shop and where.

The chatbot for WanderAR is built using Google Dialogflow. It provides 14+ languages and 16+ programming languages to be integrated. It has a more user-friendly web interface compared to other commercial platforms. We especially used it due to the ease of configuring React Native with Google Dialogflow. We use react-native-gifted-chat which provides a customizable and complete chat UI interface. The agent module incorporates NLP to understand the action to be carried out and transforms user request into machine readable data. Intent is the support or service user wants from agent and it is configured by developers. (Eg: Book a flight).

Once the agents and intents are set setup on DialogFlow, we generate a key which is a JSON file. This file is then programmed and converted to a Javascript file and added to the chatbot project file. The App.js file in the project created needs to import DialogFlow.

It uses a request query to to send request to agent. Once the bot generates a response, the state at user end is updated and result is displayed in the chat inference.

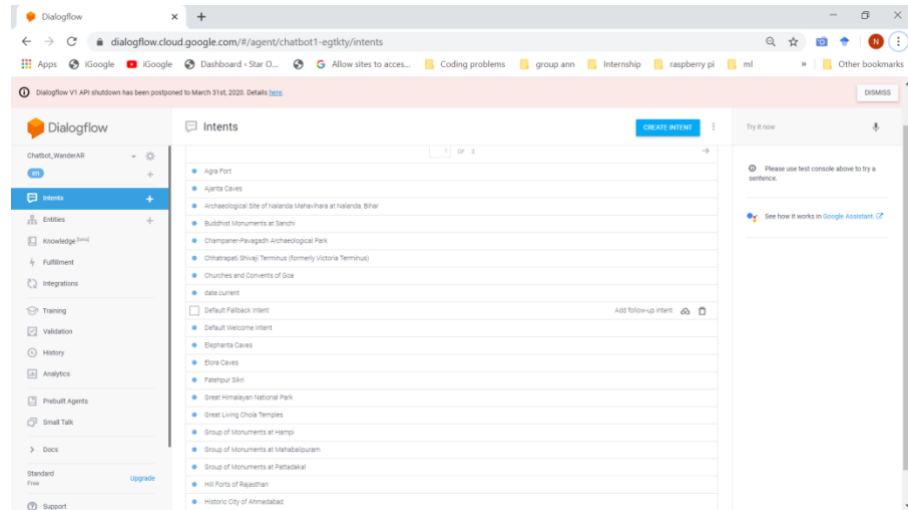


Figure 7.1 Indian World Heritage Sites in DialogFlow

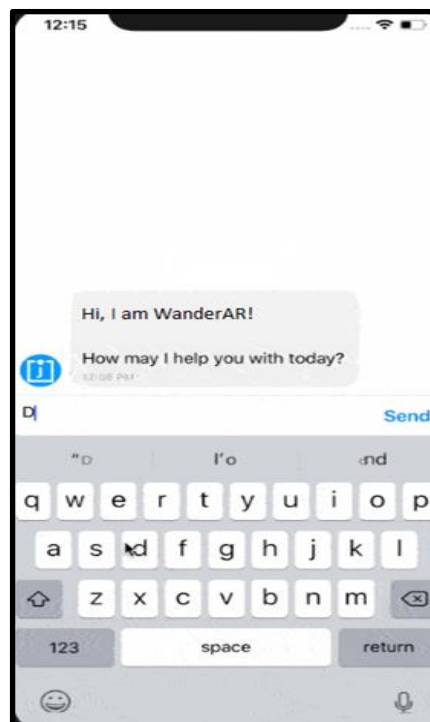


Figure 7.2 Chatbot Implementation 1

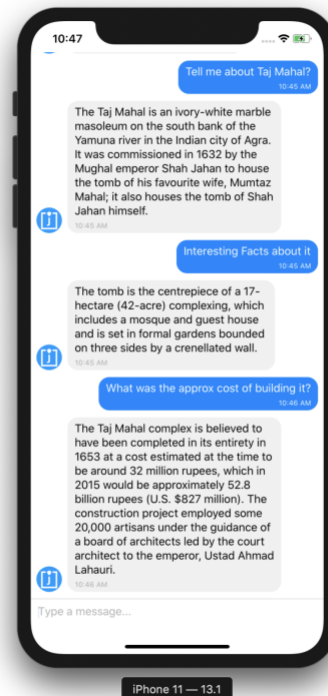


Figure 7.3 Chatbot Implementation 2

The Image recognition Module is the smallest component. It will be used to scan an image which may be of an animal, a landmark or a famous personality. It will send the image to an API from a cloud service provider and the result will be mapped to an asset in the AR module. We will try to increase its accuracy as much as possible by eliminating ambiguities arising from noise.

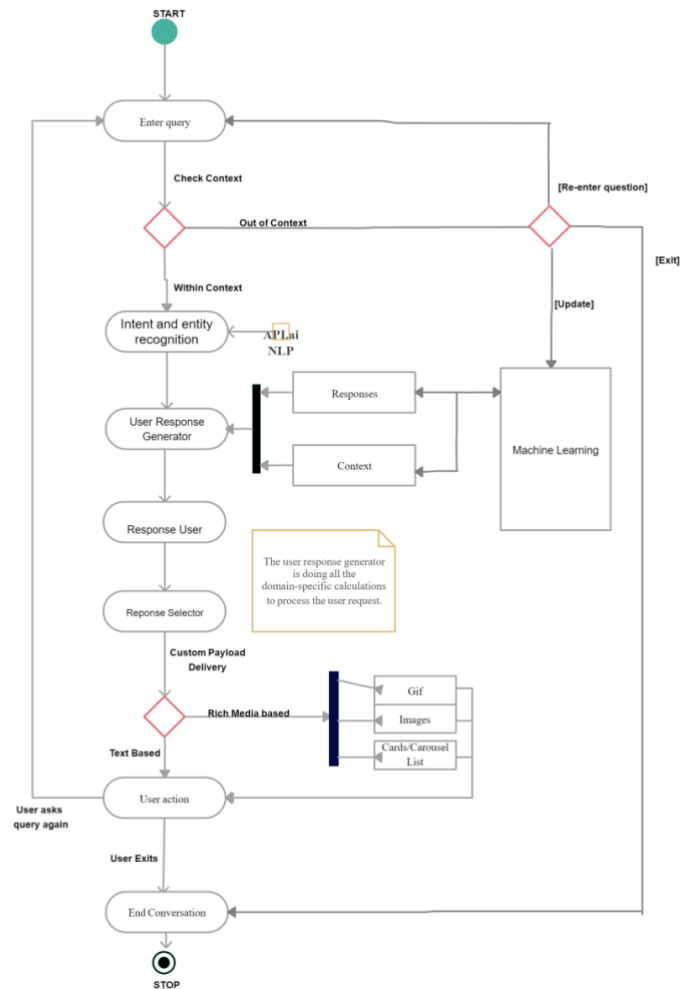


Figure 7.4 Chatbot Module - Activity Diagram

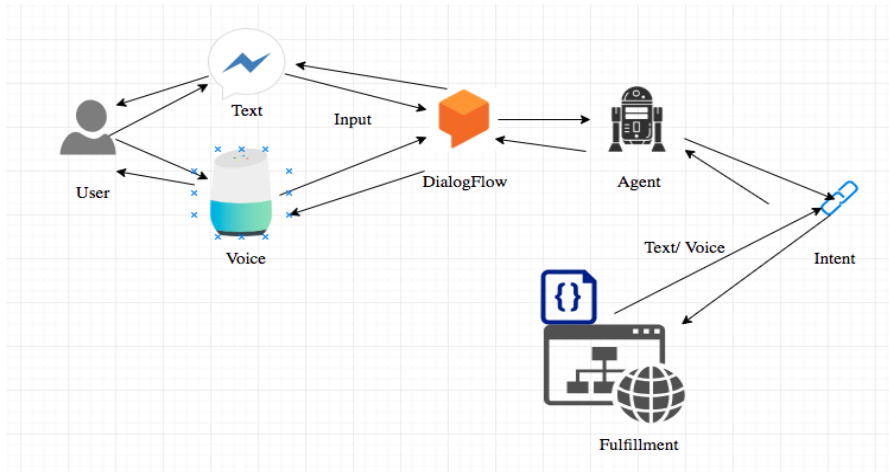


Figure 7.5 Project Use Case Diagram

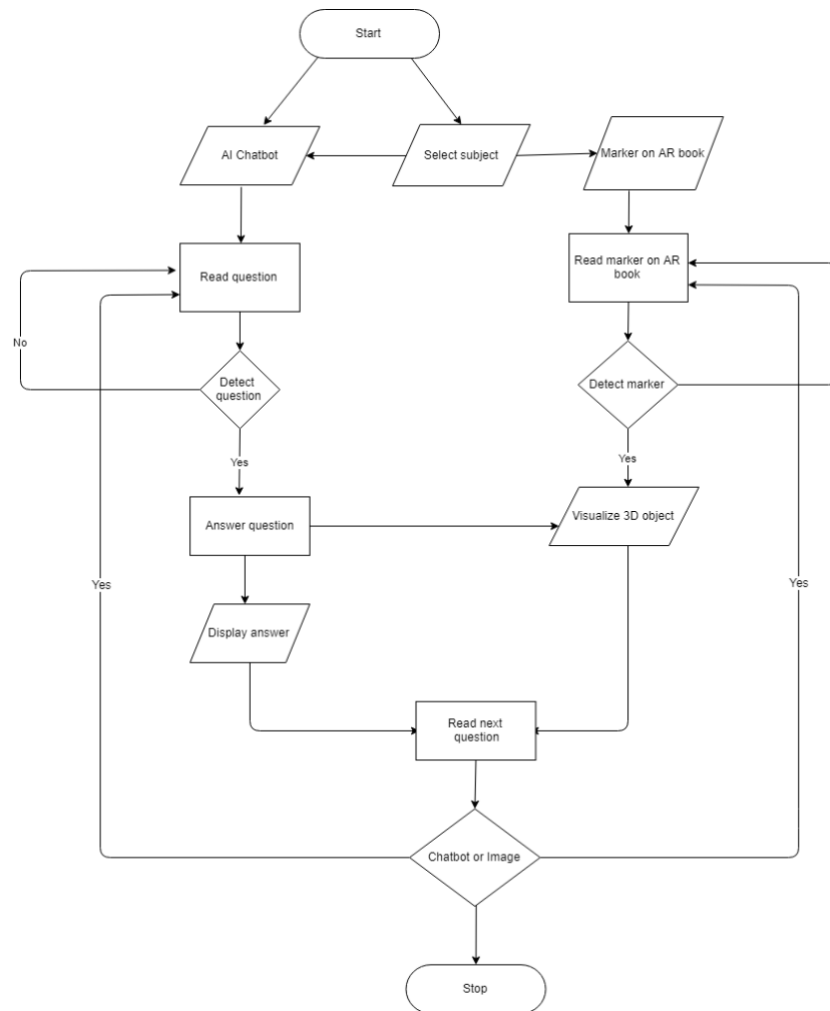


Figure 7.6 Flow Diagram of the Integration of the Chatbot and AR module

The encyclopedia module provides us with extra information and facts about a particular place. It may be represented via AR or VR. It gives us various insights about different countries – its culture, its fashion, its literature and cinema. It will be designed using ViroReact SDK. The UNESCO places will be integrated with the Google Maps API and additional historical facts will be displayed. Analysis will be done between the qualities of images represented through our convolution neural network. Machine learning will help in finding similar images and giving recommendations. This module can also access resources from the internet and lead the user to various blogs and videos.

We will be developing the AR module and collect various pictures of a particular place to depict it in 3D. We will be integrating the chatbot after adding NLP and machine learning for personalized usage. Once the three important modules are ready, we will be connecting libraries and testing and analyzing our application. We are looking forward to support Augmented Reality (AR) projections for various cultural elements like food dishes, dresses etc. Voice Search instead of having to manually having to search for a country in the encyclopedia could be a great add on which we plan on implementing. Once our project is ready, we would consider adding Virtual Reality (VR) for landmarks to provide a complete immersive learning experience for the user.

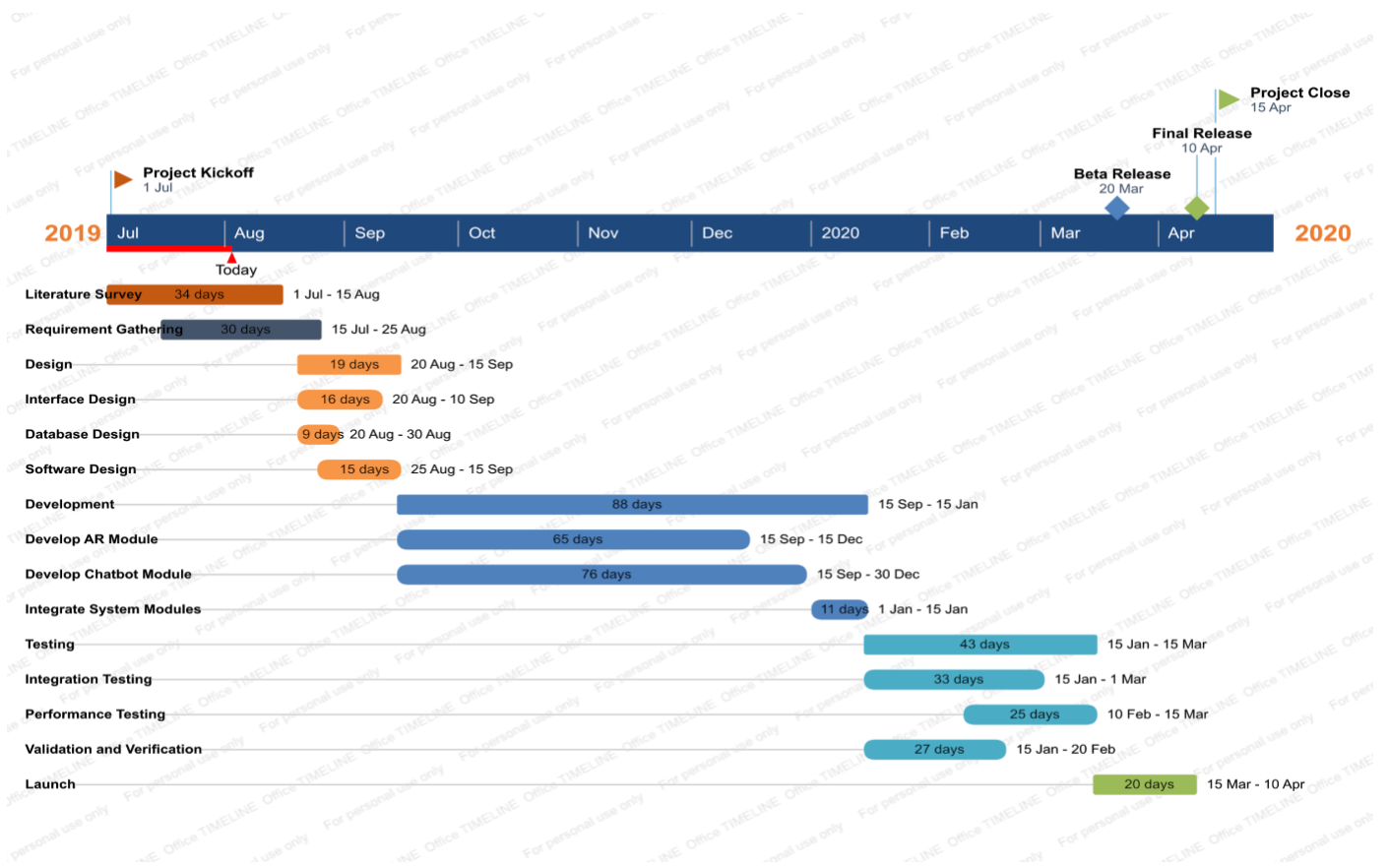


Figure 7.7 Gantt Chart representation of the project timeline

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APPENDIX

Sr. No.	Country	Easy	Medium	Difficult
1.	Afghanistan	Which is the country with highest infant mortality rate?		
2	Albania	Where was Nobel prize winner for peace Mother Teresa born?	Which country has just one Nobel prize winner?	
3	Algeria	Where was Nobel prize winner for literature Albert Camus born?	Which is the largest country in Africa?	In which country is the National Holiday known as Revolution Day?
4	Andorra	Which is the world's only co-principality?		
5	Angola	Luanda is the capital of which country?		
6	Antigua and Barbuda	Which country is known as the 'Land of 365 Beaches'?		

7	Argentina	Which country has highest number of psychiatrists per capita in the world?		
8	Armenia	Where was the first church in the world built?	Which country has chess as a compulsory subject in school?	Which was the first country to have adopted Christianity as its state religion?
9	Australia	Which country has the longest national highway in the world?	Which country has a mountain named "Mt. Disappointment"?	Which country is the world's leading producer of bauxite?
10	Austria	Which country invented the sewing machine? Which country first published postcards?	Which country created the energy drink "Red Bull"?	Which country has the largest ice cave in the world?
11	Azerbaijan	Which country has a Burning Mountain?	Which country has the most mud volcanoes?	Where is the largest mud volcano in the world?
12	The Bahamas	Which country has the clearest waters in the world?	Which country has a Pig Beach known because of its swimming pigs?	
13	Bahrain	Which country first had a skyscraper to integrate wind turbine into its design? (First wind powered towers)	Which country has the Tree of Life?	
14	Bangladesh	Which country is home to the world's largest	Which was the first country to	

		mangrove forests?	ban single use plastic?	
15	Barbados	Which country first made rum?		
16	Belarus	Which country has highest level of alcohol consumption?		
17	Belgium	Which country is number one in FIFA ranking? Which country originated French Fries?	Which country has the most castles per kilometer?	Which country is the world's leading exporter of billiard balls?
18	Belize	The Great Blue Hole is in which country?		
19	Benin	Which country is the birthplace of the vodun religion?		
20	Bhutan	Which country's national capital has no traffic lights?		
21	Bolivia	Which country has the largest salt flat in the world?	Which country is home to two of the highest cities in the world?	Which country has world's highest lake? (Lake Titicaca)
22	Bosnia and Herzegovina	Which country is known as the "Heart Shaped Land"?	Which country has the golden lily as their national symbol?	
23	Botswana	Which country has the largest elephant population?	Which country has the richest diamond mine in the world?	
24	Brazil	Which country has the most freshwater?	Which country produces the most sugar?	Which country is famous for samba dance?

			Which country is the largest exporter of coffee?	
25	Brunei	Which country has the largest residential palace in the world?		
26	Bulgaria	Which country has highest mortality/death rate?		
27	Burkina Faso	Which country is known as the 'Land of Honourable People'?		
28	Burundi	Which country changed its capital from Bujumbura to Gitega in 2019?		
29	Cambodia	Which country has the highest number of public holidays?		
30	Cameroon	Which country is called Africa in Miniature?		
31	Canada	Which is the second largest country in the world?	Which country has most number of lakes?	Which country has the longest coastline in the world?
32	Cape Verde	Which country is also known as 'The Green Cape'?		
33	Central African Republic	Bangui is the capital of which country?		

34	Chad	N'Djamena is the capital of which country?		
35	Chile	Which country is called 'Land of Poets'?		
36	China	Which is the most populated country? Which country has highest electricity consumption? Which is the world's largest producer of tea?	In what country is the Yangtze River found? Which country has highest carbon footprint? Which is the most atheist country?	Which country has maximum number of neighbours touching its border? (14) Which country has the world's largest dam?
37	Colombia	Which is the world's leading producer of emeralds?	Which country broadcasts its national anthem twice a day?	Which country has a river with 5 different colors?
38	Comoros	Which country is called the 'Perfume Islands'?		
39	Congo, Republic of the	Kinshasa is the capital of which country?		
40	Congo, Democratic Republic of the	Brazzaville is the capital of which country?		
41	Costa Rica	Which country refers to themselves as 'Ticos' and 'Ticas'?	Which country does the sun rise and set at the same time 365 days a year?	Which is the first country to ban fossil fuels?
42	Cote d'Ivoire	Which country is called the 'Ivory Coast'?		

43	Croatia	In which country was the necktie invented?		
44	Cuba	Which country created salsa dance?	What country is the rumba from?	
45	Cyprus	Which country does not have a national anthem of its town?		
46	Czech Republic	Which country first used the word 'robot'?		
47	Denmark	Which country has the largest national park?	Which country is the largest exporter of Christmas trees?	
48	Djibouti	Lac Assal, the saltiest lake outside of Antarctica, even saltier than the famous Dead Sea is located in this country		
49	Dominica	Roseau is the capital of which country?		
50	Dominican Republic	Santo Domingo is the capital of which country?		
51	East Timor	Dili is the capital of which country?		
52	Ecuador	Which country is the largest exporter of bananas?		
53	Egypt	Which country has the longest river?	Which country first invented the 365-day a year calendar?	

54	El Salvador	Which country is known as the Land of Volcanoes?		
55	Equatorial Guinea	Malabo is the capital of which country?		
56	Eritrea	Asmara is the capital of which country?	Nafka is the currency of which country?	
57	Estonia	Which was the first country to adopt online voting?		
58	Ethiopia	Where was coffee first discovered?		
59	Fiji	Which country was known as the 'Cannibal Isles'?		
60	Finland	Which is the world's happiest country?	Which was the first country to impose carbon tax?	
61	France	Which is the world's most visited country? Which is the most eco-friendly country in the world?	Which country has the most time zones? Where was the metric system first invented? Which was the first country to impose GST?	Which is the first who forbade supermarkets to throw away or burn unsold food?
62	Gabon	Libreville is the capital of which country?		
63	Gambia	Which is the smallest non island African country?	Which country is known as the 'Smiling Coast'?	

64	Georgia	Which country first made wine?		
65	Germany	Which country exports the most chocolate?		
66	Ghana	Which country is known as the 'Gold Coast'?		
67	Greece	Which was the first democratic country in the world?		
68	Grenada	Which country is known as the 'Island of Spice'?		
69	Guatemala	Guatemala City is the capital of which country?	The Quetzal is the currency of which country?	
70	Guinea	The Guinean Franc is the currency of which country?	Conakry is the capital of which country?	
71	Guinea-Bissau	Bissau is the capital of which country?		
72	Guyana	Which is the only country in South America to have English as its official language?		
73	Haiti	Which country is known as the 'Land of High Mountains'?		
74	Honduras	Which country is known as 'Banana Republic'?		
75	Hungary	Which country invented the rubik's cube?		

76	Iceland	Which is the most peaceful country?	Which is the most liberal country in the world? Which country has no mosquito?	Which was the first country to ban all types of asbestos?
77	India	Which country has world's largest youth population? Which country has largest industry by number of film production?	Which country has largest cattle inventory? Which country has wettest place in the world? (Meghalaya)	Which country has the longest written Constitution?
78	Indonesia	Which country has the largest number on their currency? (1,00,000)	Which country has largest Muslim population?	Which country has maximum earthquakes?
79	Iran	Which country has the least valued currency in the world?		
80	Iraq	Where was the world's first writing system invented?		
81	Ireland	Which was the first country to introduce a total smoking ban?		
82	Israel	Which country is the birthplace of Judaism?		
83	Italy	Which country originated pizza?	Which country has the most number of Unesco World Heritage Sites (55)?	Leonardo da Vinci was born in which country? (Anchiano)

84	Jamaica	Which was the first country to gain independence from the United Kingdom?	Which country has the most churches per square mile in the world?	
85	Japan	Which country has the best railway system?	Where are the most vending machines in the world?	Where was the karaoke machine invented?
86	Jordan	In which country is Petra located in?		
87	Kazakhstan	Which country produces maximum uranium?		
88	Kenya	Where was Barack Obama's father from?	From where does kitengala glass originate?	
89	Kiribati	Which country used to be called the 'Gilbert Islands'?	Which is the only country to be situated in all four hemispheres?	
90	Korea, North	Kim Jong-un is the leader of which country?		
91	Korea, South	Which country is known for K-pop?	The band BTS is from which country?	
92	Kosovo	Prishtina is the capital of which country?		
93	Kuwait	Which country produces most waste material?		
94	Kyrgyzstan	Which country is called the 'Pearl of Central Asia'?		
95	Laos	Which country was once known as the 'Land of a		

		Million Elephants’?		
96	Latvia	Jacob W. Davis, inventor of jeans, was from which country?		
97	Lebanon	Which country's capital was home to the world's first law school?		
98	Lesotho	Which is the world's highest country?		
99	Liberia	Which country was the first African republic to proclaim its independence?	Which country is Africa's first and oldest modern republic?	Which country was created for freed slaves?
100	Libya	Tripoli is the capital of which country?		
101	Liechtenstein	Which country in Central Europe is a double-landlocked country?		
102	Lithuania	Which country is the only country in the world with its own official scent?		
103	Luxembourg	The restaurant with the world's largest wine list is in which country?	Which country is Europe's most powerful investment management centre?	
104	Macedonia	Which country has the world's deepest underwater cave?	Which was the first country to have full access to wireless broadband?	

105	Madagascar	A Malagasy is from which country?		
106	Malawi	Where is the Calendar Lake situated?		
107	Malaysia	Which country is also known as the 'Land of Indigenous Malay'?		
108	Maldives	Which country is known as the 'Land of Sun, Sea and Sand'?		
109	Mali	Which country has the largest mudbrick building in the world?		
110	Malta	Valleta is the capital of which country?		
111	Marshall Islands	Which country's two island groups are the Ratak Chain and the Ralik Chain?	Which country's only indigenous mammal is the Polynesian rat?	
112	Mauritania	Which country is called the 'Eye of Africa'?		
113	Mauritius	Which country's national animal is the dodo?		
114	Mexico	Which country has the world's smallest volcano?	Which country is the largest silver producer? Where is the world's largest pyramid?	Which country is the world's largest exporter of beer?

115	Micronesia	Palikir is the capital of which country?		
116	Moldova	Chisinau is the capital of which country?		
117	Monaco	Which country has lowest birth rate?	Which country has the smallest written Constitution?	
118	Mongolia	Which country has lowest population density?	Which country's empire was ruled by the emperor Genghis Khan?	
119	Montenegro	Which country is called the 'Land of the Black Mountain'?		
120	Morocco	Which country has the oldest university in the world?	Which country exports Argan oil?	
121	Mozambique	Maputo is the capital of which country?		
122	Myanmar	Which is the largest country in Southeast Asia's mainland?	Where is the biggest and uncracked bell in the world found?	
123	Nauru	Which country has the highest prevalence of obesity?		
124	Nepal	Which country has no rectangular flag?		
125	Netherlands	Which place has the smallest airport in the world? (Saba)	Which city has an airport with maximum runways in the	

			world? (Amsterdam)	
126	New Zealand	Which was the first country to give women the right to vote? Which is the first place on Earth that receives the first ray of light?	From which country was the man who first conquered the heights of Mount Everest? In which country is the world's smallest marine dolphin and the rarest sea lion found?	Which was the country to win the first Rugby World Cup? Which was the first country to establish a state-run tourism department?
127	Nicaragua	Which is the largest country in Central America?		
128	Niger	Which country has highest birth rate?		
129	Nigeria	Which country has the largest diversity of butterflies?	Which country has the world's greatest birth rates for twins?	Chinua Achebe, author of successful novel 'Things Fall Apart' was born in which country?
130	Norway	Which country has the highest concentration of fjords in the world?	Which country has highest number of electric cars?	Which is the first country to ban deforestation?
131	Oman	Which is the second largest country in the Arab region?	Isla Fisher, from the movie Confessions of a Shopaholic (2009), is born in which country?	
132	Pakistan	Which country has the world's	Which country has the only	

		largest volunteer ambulance organization?	fertile desert in the world?	
133	Palau	Which is the first country to ban sunscreen?	Which was the first Latin American country to adopt the U.S. currency as its own?	
134	Panama	From which country can you see the sun rise on the Pacific and set on the Atlantic?		
135	Papua New Guinea	Which country speaks the most languages? (820)	Which is the most ethnically diverse country in the world?	
136	Paraguay	Which country is known as the 'Heart of South America', 'Land of Water' and 'Island surrounded by mainland'?		
137	Peru	Where is Machu Picchu, one of the Seven Wonders of the World situated in?		
138	Philippines	Which country's flag works as a guide for war or peace?	Which country is the world's biggest exporter of amber?	
139	Poland	Which country has the world's largest castle?		
140	Portugal	Which was the first country to		

		abolish death penalty?		
141	Qatar	Which is the richest country?	Which country has highest male ratio? Which country has lowest death rate?	Which country has no trees?
142	Romania	Which country is the birth place of the horse tram and the electric street light?		
143	Russia	What is the largest country in the world in terms of land area?	Which country has most rivers? Which country produces maximum engineering graduates?	Which country has highest literacy rate?
144	Rwanda	Which country is called the ' Land of a Thousand Hills'?		
145	Saint Kitts and Nevis	Basseterre is the capital of which country?		
146	Saint Lucia	Which country was also known as the "Helen of the West Indies"?		
147	Saint Vincent and the Grenadines	Which country's capital is known as “The City of Arches”?		
148	Samoa	Which country is known as the “Cradle of Polynesia”?		

149	San Marino	Which is the oldest country on Earth?	Which is the world's smallest republic?	
150	Sao Tome	Sao Tome is the capital of which country?		
151	Saudi Arabia	Which country has the biggest airport in the world? (Dammam)	Which is the world's largest country without a river?	
152	Senegal	Where is Akon City located?		
153	Serbia	Which country has the highest smoking rate?		
154	Seychelles	Which country has the largest population of giant tortoises?		
155	Sierra Leone	Which country has highest female ratio?		
156	Singapore	Which country is known as the 'Lion City'?		
157	Slovakia	Which country has world's highest number of castles and chateaux per capita?		
158	Slovenia	Where is the oldest vine in the world?		
159	Solomon Islands	Which country has highest electricity cost?		
160	Somalia	Mogadishu is the capital of which country?		

161	South Africa	Where was Nelson Mandela born?		
162	South Sudan	Which is the newest country?	Which country has the least access to electricity?	Which country has the lowest literacy rate?
163	Spain	Which country has the most nightclubs?		
164	Sri Lanka	Which country is famous for ceylon tea?		
165	Sudan	Which country has maximum number of pyramids?		
166	Suriname	Which is the smallest independent country in South America?	Which country is known for Dutch sugar plantations?	
167	Swaziland	Which country has the capitals Mbabane and Lobamba?		
168	Sweden	Which country has the most islands?		
169	Switzerland	Which is lowest crime rate country?		
170	Syria	Which is the world's most war-torn country?		
171	Taiwan	Which country is called the 'Republic of China'?	Which country has largest collection of Chinese art in the world?	Which country has been dubbed the "face mask capital of Asia"?

172	Tajikistan	Dushanbe is the capital of which country?		
173	Tanzania	In which country was the shortest war in history fought?	Where was Freddie Mercury born?	
174	Thailand	Which country celebrates the Monkey Buffet Festival?		
175	Togo	Lome is the capital of which country?		
176	Tonga	Which country is also called 'Friendly Islands'?		
177	Trinidad and Tobago	Nicki Minaj is from which country?		
178	Tunisia	Tunis is the capital of which country?		
179	Turkey	Which country is the world's biggest producer of hazelnuts, figs, apricots and raisins?		
180	Turkmenistan	Which country's capital holds the Guinness World Record for having the highest density of marble buildings in the world?		
181	Tuvalu	Which country has lowest GDP?	Which is the least visited country?	Which country used to be called

				the 'Ellice Islands'?
182	Uganda	Which country is called the 'Pearl of Africa'?		
183	Ukraine	Which country is known as the 'Bread Basket' of Europe?		
184	United Arab Emirates	Where is the tallest building in the world located?		
185	United Kingdom	Which country's scientist first invented the world wide web?		
186	United States of America	Which country has highest number of millionaires? Which country's Government controls the GPS?	Which country has won the most Nobel prizes? Which country has won maximum Olympic medals?	Which country has highest GDP? Which is the world's biggest oil consuming country?
187	Uruguay	Which country has the world's longest national anthem?		
188	Uzbekistan	Which country is Asia is a double-landlocked country?		
189	Vanuata	Which country has origins of bungee jumping?		
190	Vatican City	Which is the smallest country in the world?		

191	Venezuela	Which country has world's highest waterfall?	Which country has highest crime rate?	Which country has largest amount of oil reserves?
192	Vietnam	Which country is also known as the 'Land of Ascending Dragon'?		
193	Yemen	Which is the most conservative country?		
194	Zambia	Lusaka is the capital of which country?		
195	Zimbabwe	Which country's cricket board has been suspended by the International Cricket Council?		