CHAPTER 3

DATASET DESCRIPTION

3.1 INTRODUCTION

Data collection for the research involved a blend of gathering of data through survey and datasets from Kaggle. Survey wes conducted to collect the data from the users about the learning environment, to enhance the educational experience, improve engagement and learning outcomes. Datasets from Kaggle was used for enabling deeper analysis and development of the application.

3.2 Data Collection Methodology

The proposed methodology for data collection in immersive learning is depicted in ***Figure 3.1***.

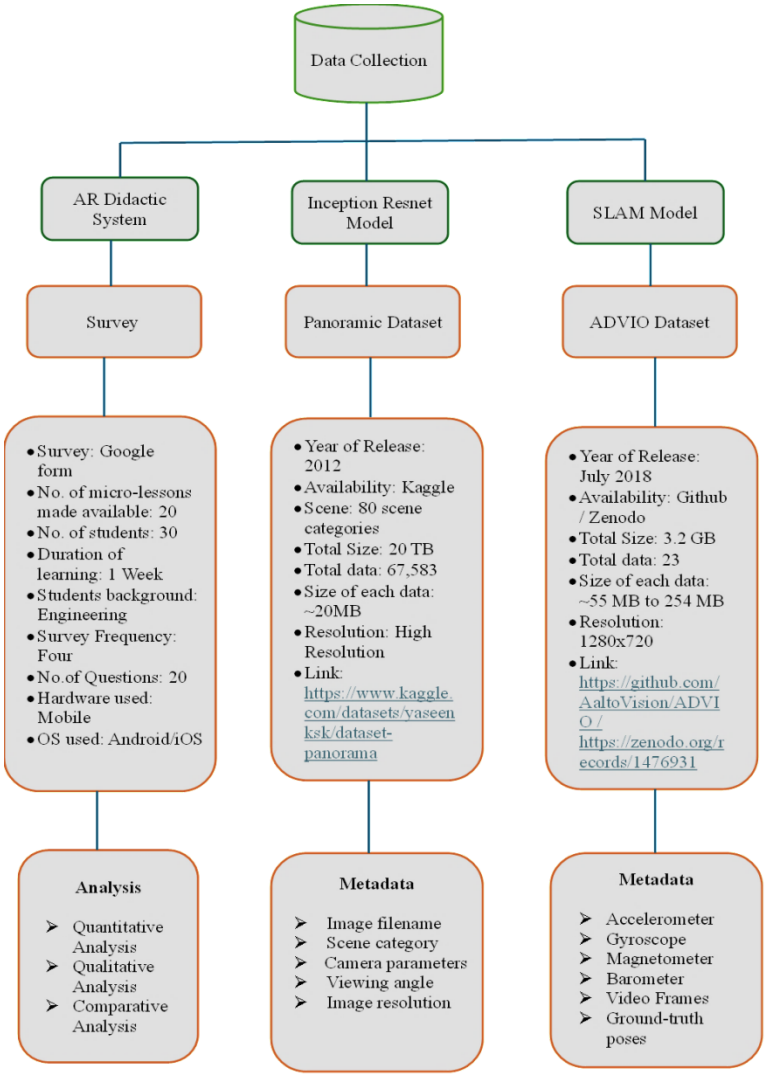

Figure 3.1 Data Collection Methodology

Figure 3.1 outlines the sources and methodology used for collecting data across three key components of an Augmented Reality (AR)-based didactic system. The components for survey are AR Didactic System, Inception ResNet Model, and SLAM Model. For developing the AR Didactic System, a survey was conducted using Google Forms involving 30 engineering students, who engaged with 20 micro-lessons delivered via Android and iOS mobile devices. The survey spanned one week, consisting of four rounds and 20 questions aimed at gathering feedback for quantitative, qualitative, and comparative analysis. In the second component, the

Inception ResNet Model was trained using the SUN360 panoramic dataset, released in 2012 and sourced from Kaggle. Finally, the SLAM Model was supported by the ADVIO dataset, released in July 2018 and obtained from GitHub and Zenodo. It consists of 23 sequences of high resolution image.

3.3 SURVEY BASED DATA ACQUISITION

Survey parameters such as User Satisfaction, Learning Outcome Improvement, Ease of Use, Interactivity, Engagement, Usability, Content Quality, Immersion & Interactivity, and User Satisfaction are selected based on educational technology evaluation frameworks and human-computer interaction (HCI) standards. These parameters help assess the effectiveness, user experience, and educational value of AR applications

3.3.1 Input Variables

Input variables in immersive based learning are the data point collected from the users, learning environment and user-device interaction. These input variables drive the ability to personalize the content, track the learning progress and improve user engagement. The input variables are as follows.

- User profile and demograplic variable
- Learning behaviour and interaction variable
- Performance and learning outcome
- Environmental and contextual variable
- Feedback and user satisfaction
- AR object and content interaction

User profile and demographic variable

The user and demographic variable helps to customize the learning experience based on the users' background and preferences. The data collection includes the name, age, gender,educational level, subject preference, learning goals, accessiblity requirments and language preferences.

Learning behaviour and interaction variable

Learning behaviour and interaction tracks how the user engages with immersive content. The contents include session duration, feature usage, navigation pattern, touch and gesture data.

Performance and learning outcome

These input variables plays a vital role in measuring the learning success and content adaption. Quiz, completion rates, learning retention, adaptive learning data and retry rates are few input variables that helps in tracking the performance of the user.

Environmental and contextual variables

The environmental and contextual variables help the computer generated AR object allign with the user's real world setting such as light conditions, plane detection, mid-air detection, network connectivity and device oritntation.

Feedback and user satisfaction

The feedback and user satisfaction reflects the user preferences and satisfaction criteria. The survey responses, suggestions, engagement metrics and usage of the app provides valuable insights into user satisfaction, learning effectiveness and help to identify the areas of improvement.

AR object and content interation

AR object and content interaction helps to track the user interaction with the immersive content through object selection, manipulation behaviour like resie, rotate and move objects, interaction and proximity to objects.

The input variables in AR- based learning environment has a major role in shaping the users' experience , improve learning outcome and enhance engagement. Each and

every input variable directly or indirectly influences on the adaptation of the learning environment based on user needs, tracks the user performance and delivers the content. The main goal is to personalize learning experience, increase engagement and improve knowledge retention. The input variables and their purpose is given in ***Table 3.1.***

Table 3.1 Summary of input variable categories

S.No	Input Variables	Purpose	Examples
1	User profile & demography	Personalization	Age, Subject preference
2	Learning behaviour and interaction	Enagagement Tracking	Session duration, Gesture Data
3	Performance and learning outcomes	Measure learning outcomes	Quiz results, error rates
4	Environment and context	Improves object placement and interaction	Light intensity, surface detection
5	Feedback and user satisfaction	User experience improvement	Ratings , Surveys and Suggestions.
6	AR object and content interaction	Enhance the content use	Object selection

3.3.2 Target Variables

The target variables in immersive based learning represent the goal or outcome that the immersive learning app aims to improve. The target variables are influenced by the input variables(profile, behaviour, environmental data) and are used to messure the success of the interactive learning platform in terms of learnin effectiveness, engagement and user satisfaction. The target variables are as follows.

- Learning outcome variables
- Engagement and interaction variables
- User satisfaction and feedback variables
- Performance and technical variable
- Adaptive learning and personaliation

Learning outcome

The learning outcome variables assess the knowledge retention and improvement including quiz scores, completion rate and adaptive learning success with better result indicating stronger learning outcome.

Engagement and interaction

This variable tracks the user activity such as session duration, feature usage and revisit rates with increased interaction indicating higher motivation.

User satisfaction and feedback

The user satisfaction and feedback measures the immersiveness through the ratings, surveys and quantitative feedback helping guage the overall user experience and retention.

Performance and technical variable

The performance and technical variables eveluates the application's functionality and efficiency in delivering the content. The key factors include app crash rates, loading time, with fster speed enhancing user interaction. The AR object placement accuracy improves immersion by ensuring percise positioning.

Adaptive learning and personalization

The adaptive learning and personalization assess the application's ability to customize content based on individual learning style and progress. Higher engegement with tailored content reflects successful adaptation, while seamless difficulty adjustment help maintain motivation and challenge balance.

The target variables highlights the essential factors in evaluating an immersive learning app's success across learning, engagement, satisfaction, performance and personalization. The output variables and its purposes are shown in the ***Table 3.2***.

Table 3.2. Summary of Target Variable categories

S.No	Catagory	Purpose	Example
1	Learning Outcomes	Measure learning effectiveness	Completion rate, Retention rate
2	Engagement	Track user interest and activity	Session duration, Revisit rate
3	User Satisfaction	Evaluate user experience	Rating, survey feedbacks
4	Technical Performance	Optimize app's performance	Loading time, latency
5	Adaptive Learning	Track effectiveness of personalization	Content engagement, Difficulty adjustment

3.3.3 Survey Framework

The survey framework designed to evaluate the effectiveness of an AR-based learning application using five key parameters. Content Comprehensibility assesses whether the lesson content is easily understandable in a single session. Learning Flexibility measures the user's ability to learn at their own pace and adapt the content to their preferred learning style. Experiential Learning evaluates how well the AR overlays create a realistic, immersive experience with compelling visual effects. Audio/Visual Clarity checks if the audio and video components are clear and supportive of the learning process without distractions. Lastly, Sustained Engagement examines whether the app's visuals and narration maintain learner interest throughout the lesson. Each of these parameters is rated on a 5-point Likert rating scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), allowing for a quantitative evaluation of users' experience and educational effectiveness(***Table 3.3***).

Table 3.3 Survey Parameters

Survey Parameters	Survey Form	
Content Comprehensibility	Lesson content understandable in one experience	**Rate it on a scale of 5 (Strongly Disagree - 1 Disagree – 2 Neutral – 3 Agree - 4 Strongly Agree - 5)**
Learning Flexibility	Ability to learn at your own available time and use your learning style	
Experiential Learning	The overlay content gave a virtual feel of reality with good visual effects.	
Audio/Visual Clarity	The audio and visuals were clear and did not hinder the learning process	
Sustained Engagement	The lesson narration visuals were entertaining and captured the attention	

3.4 INSIGHT OF OPEN-SOURCE DATASET

Two different datasets are used for the research purpose. They are Panorama dataset and ADVIO dataset.

3.4.1. Panorama Dataset

The SUN360 dataset was released in 2012 and is currently available on Kaggle for public access. It features a diverse collection of 67,583 high-resolution panoramic images spanning 80 different scene categories, making it a valuable resource for tasks involving scene understanding, environment modeling, and panoramic image analysis. The total dataset size is approximately 3.2GB, with individual image files ranging from ~55MB to 254MB each. The dataset is particularly notable for its high-resolution quality, which enables detailed analysis and realistic rendering in applications like computer vision, virtual reality, and augmented reality.

3.4.2. ADVIO Dataset

An Authentic Dataset for Visual-Inertial Odometry(ADVIO dataset) was realeased by AaltoVision through Github and Zenodo repository in 2019 which comprises of 23 real world indoor and outdoor sequences with 1280x720 resolution images. It includes scenarios such as shopping malls, metro station, buildings and urban outdoor settings. It captures the synchronized raw sensor data like accelerometer, gyroscope, magnetometer, barometer, camera frames with 6 DoF. The sensor data are in CSV format with synchronied timestamp with camera frames.

3.5 EXPERIMENTAL SETUP

The proposed research work for developing an immersive learning application involves improving engagement and knowledge retention. The experiment utilizes AR-compatible devices and Unity 3D Engine and Vuforia , intergrating with Learning Management System. Content development includes 3D models, animations using blender and adaptive learning modules. The study involves control groups, the group with traditional methods and experimental group, the group with AR-enhanced learning. The data collection mainly focus on learning outcomes, engagement, user satisfaction and technical performance. Testing includes usability test and feedback loops to refine the features. The data analysis compares the group performance to enhance interaction, ensuring more effective learning experience. The experimental setup for evaluating the AR-based learning application involved a structured implementation plan aimed at capturing both user experience and learning effectiveness. A total of 20 micro-lessons were made available to 30 engineering students over a one-week learning period. The students accessed the content using mobile devices running on Android and iOS

platforms, ensuring accessibility across common hardware configurations. To gather feedback, a Google Form survey comprising 20 questions was administered at four intervals throughout the study, allowing for periodic insights and tracking changes in perception over time. This multi-stage survey approach helped capture a comprehensive view of student engagement, flexibility, and learning outcomes, forming the basis for both quantitative and qualitative analysis.

- Survey: Google form
- No. of micro-lessons made available: 20
- No. of students: 30
- Duration of learning: 1 Week
- Students background: Engineering
- Survey Frequency: Four
- No.of Questions: 20
- Hardware used: Mobile
- OS used: Android/iOS

3.6 SUMMARY

Survey-based data collection focuses on gathering structured responses from the users through different methods like survey, interview,etc. The panorama dataset provids a big, rich, multimodal data for visual and spatial analysis. The ADVIO dataset provides a detailed synchronized sensor data evaluating the localiation and navigation systems. Each approach used in the research ensures efficient data acquisition and help in effective analysis.