SENTIMENT ANALYSIS OF AR AND VR IN MULTIPLE SECTORS USING USER EXPERIENCE FROM SOCIAL MEDIA

BY

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FINAL YEAR DESIGN PROJECT REPORT

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "Sentiment Analysis of AR and VR in Multiple Sectors Using User Experience from Social Media", submitted by Mahmudur Rahman to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 15-7-2024.

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DECLARATION

We hereby declare that, this project has been done by **Mahmudur Rahman** under the supervision of **Most. Hasna Hena (HH), Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Augmented Reality (AR) and Virtual Reality (VR) technologies are revolutionizing how we engage with digital content, providing new experiences in gaming, entertainment, and beyond. Understanding users' opinions and attitudes around these developing technologies is critical for increasing adoption and user happiness. This study uses sentiment analysis approaches to analyze user experiences with AR and VR applications in the gaming and entertainment industries, utilizing data from social media platforms. The researchers used a combination of machine learning models, such as Naive Bayes, Support vector machine (SVM), and Random Forest, to determine whether user reviews and comments expressed positive or negative sentiment. The data show that people have a higher positive opinion of VR in gaming, with 46% expressing positive sentiments compared to 42% for AR gaming. In contrast, the entertainment sector reported a larger percentage of positive attitudes for AR (53.7%) than for VR (34.3%), implying that AR is better suited for immersive entertainment experiences. The study also identified critical aspects that influence user experiences, such as visual quality, comfort, and navigational challenges for VR and design, battery life, and confusing controls for AR. These insights can help developers and stakeholders improve the design and implementation of AR and VR technologies in order to better fulfill user needs and foster widespread adoption. The study helps to a better understanding of user impressions of AR and VR by conducting a complete sentiment analysis across many domains. The findings and conclusions addressed in this study can help to shape future research and development efforts in the AR and VR fields, ultimately boosting the quality and accessibility of these disruptive technologies.

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INTRODUCTION

1.1 Overview

Augmented reality aka AR and virtual reality aka VR has surfaced as a dominant technological tool with revolutionary potential across multiple industries in today fast changing technological prospect. AR enhances the real world by covering it with digital information, whereas, users become absorbed in simulated environments by VR. Nowadays conventional industries such as entertainment, gaming, healthcare, and education have started to be manipulated by this dynamic duo from improving gaming experiences to transforming medical training, showcasing their adaptability and extensive effect.

I aim to explore the significant impact of AR and VR within the mentioned sectors and thoroughly analyze their uses, benefits, and challenge in this report. By performing thorough analysis and evaluation, we attempt to learn first-hand insights into the users' perspective of AR and VR technologies with a view to providing practical suggestions that can improve further innovation and refinement in the integration of AR and VR across various fields.

1.2 Background and Present State

Augmented Reality (AR) and Virtual Reality (VR) technologies have advanced significantly in recent years, changing how we interact with digital information and delivering immersive experiences in a variety of disciplines, including gaming, entertainment, and beyond. These developing technologies have acquired great appeal, with AR augmenting the actual world by superimposing digital information and VR allowing users to become completely immersed in virtual situations.

Conventional sectors, such as entertainment and gaming, have begun to integrate these dynamic technologies, demonstrating their versatility and broad influence. As these technologies progress, knowing user sentiment and opinions around AR and VR apps is critical for increasing adoption and user happiness.

This research will investigate the enormous influence of AR and VR on the gaming and entertainment industries, extensively examining their applications, advantages, and

problems. Using a dataset of 1,600 user evaluations evenly dispersed among Gaming AR, Gaming VR, Entertainment AR, and Entertainment VR categories, the researchers used sentiment analysis techniques to acquire firsthand insights into user perspectives of these technologies.

The study's findings provide significant information for stakeholders, developers, and academics, underlining the need of addressing technological issues and user interface concerns in order to enhance overall user experience and promote increased adoption of AR and VR technologies.

1.3 Problem Statement

When it comes to fully estimating consumer judgment for both technologies at the same time, there exists a huge gap in researches, despite the range of usage of AR and VR apps is widespread. As majority of the paper works focus on certain topics, such as education, the study of AR and VR's user perspective is heavily overlooked. The intention of sentiment analysis on user reviews is to bridge the existing gap by providing a detailed perception of the wider range of user sentiments.

1.4 Motivation and Objectives

The motivation behind this research is the confined aspects of the present sentiment analysis and the increasing importance of AR and VR across industries. We aim to provide developer, researchers, and industry stakeholders with practical insights of user's perception by determining user sentiments with a view to improving user satisfaction, application usability, and the overall user experience.

1.5 Project Scope

The sentiment analysis of user reviews , post of AR and VR applications posted on social media is the focus of this paper where we cover a variety of fields including gaming, education, healthcare, entertainment, and more. In order to provide a fair representation of user experiences, the analysis will depict a wide range of opinions, including positive, negative, and neutral.

1.6 Report Organization

We carefully arranged separated chapters for the detailed study of sentiment analysis in social media apps for augmented reality (AR) and virtual reality (VR). Each chapter fulfills a specific role, resulting in an in-depth knowledge of consumer views within the AR and VR area.

In the Introduction we presented what the study is about and why it's essential to understand the feelings of customers when exploiting AR and VR bringing forward the objectives and showing the usage of sentiment analysis in determining user experiences

The Literature review reviews the amount of prior study on this topic. The objective is to determine what has been explored by others and find the knowledge gaps, and what frequent patterns come up. This determines how the research will be conducted.

In the Methodology we covered the conduction of the research. It lays down a variety of activities (Chapter 3, in particular) explores the detailed methodology taken on for collecting, analyzing, and interpreting data.

Finally, the study's conclusions are compiled. All of the sentiment analysis data is interpreted in this chapter making inferences and providing information on the many applications of AR and VR. The chapter is structured to be easier for readers to follow along logically and comprehend how individuals are feeling in the increasingly growing realm of augmented and virtual reality technology.

1.7 Summary

In summary, this chapter provides an overview of the study objectives, scope, outcome and methods, setting the context for the report's succeeding sections. It establishes the foundation for a comprehensive analysis of AR and VR technologies in diverse sectors.

CHAPTER 2
BACKGROUND

2.1 Overview

This study of literature carefully analyzes prior reviews on sentiment analysis of consumer experiences with Augmented Reality (AR) and Virtual Reality (VR) applications . Through evaluating past efforts, the paper attempts to set down the foundation for comprehending the current status of sentiment analysis in the field of AR and VR technologies.

2.2 Related Works

Based on 10,457,344 tweets from 2010 to 2020, the paper[1] evaluates the mass's views and emotions on the use of virtual reality (VR) in general and in education. The data is processed using text mining and sentiment analysis techniques to gain insights in the paper. When referring to its use in education, the paper finds that, the public has a positive perception of VR and expresses mostly anticipation, trust and joy. The paper also emphasizes on how VR can be used as an effective educational tool which can improve students' engagement, motivation and performance.

The literature on user experience (UX) and customer experience (CX) evaluation methods in virtual reality (VR), augmented reality (AR), and metaverse12 are reviewed on this paper[2] where the authors adhere to a review protocol and consult five representative databases45. They find studies related to the UX in VR and AR, however not to the metaverse2. Moreover, they recognize various evaluation methods, such as surveys, questionnaires, heuristic evaluations, user tests, physiological signals, and algorithms. The features or characteristics that the evaluation techniques emphasizes, for example, immersion, embodiment, usability, presence, interactivity, and emotions are also analyzed by them. In conclusion, they suggest that there is a lack of assessment on CX and metaverse evaluation, and propose further work on extending the literature review and developing evaluation guidelines for VR, AR, and metaverse3.

In the context of shopping centers, the paper[3] researches the anticipated consumer experience and requirements of mobile augmented reality (MAR) services. Twenty

eight individuals participated in 16 semi-structured interview sessions arranged by the authors in the given context. The results reveal various pragmatic and hedonic attributes of the expected user experience, such as efficiency, empowerment, inspiration, liveliness and playfulness. The authors also identify several user requirements that affect the overall user experience, such as relevance, personalisation, reliability, privacy and safety. The thesis offers implications for the design of MAR services and advances knowledge of their potential and challanges.

Using the User Experience Questionnaire (UEQ) to measure the impressions of 56 participants who used either touchpoint to make product decisions, the paper[4] compares the user experience of the IKEA Place AR App and the IKEA website. According to the results, when it comes to stimulation and novelty (which are critical factors for creating a positive brand image and customer loyalty) the IKEA Place AR App offers a more engaging and innovative user experience than the IKEA website. In conclusion, the paper states that innovative digital touchpoints, such as AR apps, can improve both the user experience and the brand experience.

This paper[5] explores what factors affect users' experience and satisfaction using augmented reality (AR) apps while purchasing cosmetics online. The authors adopts a model based on the stimulus-organism-response (SOR) paradigm and include constructs such as fit confidence, social value, innovativeness, perceived utilitarian value, perceived hedonistic value, immersion, and continued usage intention. The data collected from 394 Romanian women who use AR apps for virtual try-on of makeup products are analyzed by using partial least squares structural equation modeling (PLS-SEM). The results show that fit confidence, innovativeness, immersion, and social value have the strongest direct influences while other constructs have noticeable effects on the continued usage intention of AR apps as well. The paper contributes to the literature on AR in e-commerce and offers recommendations for retailers and marketers looking to improve customer experience and satisfaction using AR apps.

By analyzing large-scale review data from the Steam platform in English, Simplified Chinese, and French this paper[6] explores the user experience of virtual reality (VR) games. It uses data mining, natural language processing, and topic modeling techniques, including Latent Dirichlet Allocation (LDA), Term Frequency-Inverse Document Frequency (TF-IDF), and K-means Clustering. The four key aspects: the

tendency of VR games, cross-linguistic analysis of player preferences, the impact of VR gaming experiences on varied user populations, and the cybersickness in VR games are the focus of the research. The paper contributes in providing valuable insights for VR game developers, researchers, and the gaming community, aiming to enhance the quality, accessibility, and enjoyment of VR gaming experiences.

This paper[7] explores the public perception of HoloLens 2, a wearable mixed reality headset, during the COVID-19 pandemic using aspect-based sentiment analysis. By collecting and annotating 8492 tweets related to HoloLens 2 and using various word-embedding and classification models the authors classified the sentiment of each tweet and ended up with the results showing that the bag-of-words model with random forest achieved the highest accuracy of 81.29%. The paper also gathered insights for MR developers, researchers, and users by analyzing the changes in sentiment over the time. The paper discovered new use cases of HoloLens 2 in health care that spiked a positive sentiment. The paper contributes to a better understanding of the public acceptance and potential of MR technologies during the pandemic.

In this paper[8] By using a hybrid approach which is a combination of sentence extraction and sentence compression, this paper presents a unique approach to automatic summarization of scientific papers. The method works in two steps. First, it extracts the significant sentences from the abstract, introduction, and conclusion sections of the article. Second, applies a compression algorithm based on syntactic rules and word importance scores which results in a reduced length of the sentences. By using a corpus of fifty engineering articles,the paper evaluates the performance of the method and compares it with two baseline methods: Lead, which selects the first sentences of the article, and LexRank, which ranks the sentences based on their lexical similarity. According to the research, the suggested strategy, out of the three, has the greatest ROUGE ratings, demonstrating that it produces more organized and informative summaries.

2.3 Comparison between existing works

In order to identify similarities, contradiction, and, most importantly, the gaps; we shall compare the works discussed above. As current literature focuses on certain topics such as education, leaving a significant research gap in user attitudes towards AR and VR

applications even though numerous studies have been listed. The deprivation of a comprehensive investigation on user sentiment for both AR and VR technologies at the same time is the main challenge, which hinders our understanding of the complete user experience. This comparative analysis aims to not only detect resembles and differences, but also points out what is needed to fill this research gap. The objective is to contribute to a thorough understanding of user feelings and the overall user AR and VR user experience.

Table 2.3.1. Comparative analysis with previous work

SL No	Author Name	Used Algorithm	Best Accuracy with Algorithm
1.	K. Unnamalai. [8]	Naive Bayes, Support Vector Machin	Support Vector Machine: precision = 0.86
2.	J. Dong. [6]	Latent Dirichlet Allocation (LDA), Non-negative Matrix Factorization (NMF), and K-means clustering	NMF: The best topic coherence score is 0.58
3.	H. Jeong. [7]	Logistic regression,Random forest,XGBoost,Support vector machine,Bag-of-words,TF-IDF	Random forest at 81.29%
4.	G. Lampropoulos. [1]	TextBlob, VADER, EmoLex	_____
5.	M.-C. Voicu. [5]	Partial Least Squares Structural Equation Modeling, heterotrait–monotrait ratio	_____
6.	Stumpp, S. [4]	Linear regression,Decision tree,Random forest	Random forest: R2 = 0.76

7.	J. Morales et al. [2]	Adaptive bucket, Mean Opinion Score	adaptive bucket reduce the RMSE by 28.6%

Despite the significant contributions made by previously published publications, there is still exists an noticeable gap in the literature. The broader spectrum of AR and VR user experiences are heavily overlooked by major publications as they narrow their visions on fields like gaming or education. This study seeks to address the gap by doing a more thorough sentiment analysis across several fields of both AR and VR, resulting in a deeper knowledge of user sentiments.

Moreover, existing studies are mostly focused on either AR or VR solely leaving off the mixed emotions when both technologies are used in combine. This research aims to bridge the gap by performing a comprehensive sentiment analysis that takes into account the unique features of both AR and VR experiences at the same time.

2.4 Open Issues

Despite the significant contributions made by previously published publications, there is still exists an noticeable gap in the literature. The broader spectrum of AR and VR user experiences are heavily overlooked by major publications as they narrow their visions on fields like healthcare and education. This study seeks to address the gap by doing a more thorough sentiment analysis across several fields of both AR and VR, resulting in a deeper knowledge of user sentiments. Moreover, existing studies are mostly focused on either AR or VR solely leaving off the mixed emotions when both technologies are used in combine. This research aims to bridge the gap by performing a comprehensive sentiment analysis that takes into account the unique features of both AR and VR experiences at the same time.

2.5 Summary

In summary, the literature review offers an in-depth review of existing research on sentiment analysis for AR and VR applications. This chapter reveals an important gap in the existing research by comparing methodologies, domains, and findings.

CHAPTER 3
METHODOLOGY/ REQUIREMENT ANALYSIS & DESIGN SPECIFICATION

3.1 Overview

The focus of this study is on AR and VR uses in the entertainment and gaming industries. Sentiment analysis is used to examine social media reviews and comments in order to gain insight into user perceptions. Using machine learning models such as Naive Bayes, SVM (Support vector machine), and Random Forest, we first clean and prepare the text data before interpreting the sentiments. We assess these models' performance using techniques like classification reports and confusion matrices. We can precisely measure user attitudes and determine what influences their positive or negative experiences thanks to this combination of tools.

3.2 Proposed Methodology

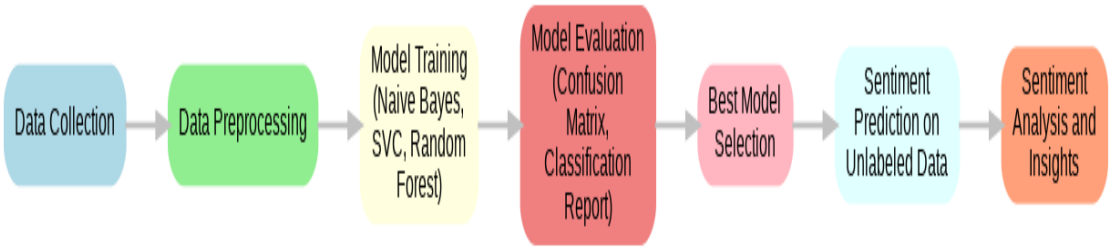

FIGURE 3.2.1: BLOCK DIAGRAM OF PROCEDURE

The sentiment analysis study uses a multi-step approach to extract user experiences with AR and VR applications from social media data:

Data Collection Procedure:

The data for this sentiment analysis was rigorously gathered from a range of user review sources, with an emphasis on social media platforms and review websites. Several efforts were taken during the gathering phase to guarantee that the dataset was thorough and representative.

To begin with, web scraping techniques were used to collect customer reviews. Web scraping is the process of obtaining data from webpages utilizing strong technologies like BeautifulSoup and Selenium. BeautifulSoup, a Python package, played an important role in parsing HTML and XML documents, allowing valuable data to be

extracted from websites. Selenium, a web automation tool, was used to explore online sites and capture dynamic material that was not accessible via static HTML alone. Together, these techniques guaranteed that the data obtained was detailed and comprehensive. The data sources were carefully picked to offer a comprehensive snapshot of user emotions. The reviews were sourced from popular sources, including:

- Facebook: As one of the most popular social media platforms, Facebook generated a plethora of user comments and debates about AR and VR experiences in gaming, entertainment, and other industries. The public nature of Facebook posts allowed the researchers to get unfiltered user input and attitudes concerning these developing technologies.
- Reddit: Known for its thorough user conversations, Reddit provided in-depth comments on numerous AR and VR experiences, helping to create a more nuanced dataset.
- Amazon: reviews concentrate on product-specific comments for AR and VR devices, emphasizing user experiences with the gear.
- Google Play Store: This platform offered app-specific evaluations for AR and VR applications, indicating both user happiness and software concerns.
- Apple App Store: Similar to Google Play, this source provided app-specific evaluations, gathering user feedback on AR and VR applications for iOS devices.

A total of 1,600 user reviews were collected, providing adequate data for further examination. These reviews were evenly spread across four categories, each comprising 400 reviews. This distribution was intended to ensure balance and comparability across industries.

Preprocessing:

A set of preprocessing techniques were used to clean and normalize the text data before it was analyzed for sentiment. These procedures are critical to ensuring that the text data is properly formatted for accurate analysis. The preprocessing approach consisted of the following specific steps:

Tokenization:

Tokenization is the process of breaking down a text into individual words or tokens. This stage was completed using the NLTK library's word_tokenize function, which divides the text into tokens based on whitespace and punctuation.

Lowercasing:

Converting all text to lowercase maintains consistency in the text data. This step assists in considering words with distinct cases (e.g., "Hello" and "hello") as the same token during analysis.

Remove Punctuation:

Punctuation markers (such as commas and periods) do not usually add to the meaning of the text in sentiment analysis. As a result, they were eliminated from the text data using Python's built-in string package, which includes a set of punctuation characters.

Stemming:

Stemming is the process of reducing a term to its root or basic form. This step aids in word standardization by treating variants of the same word (e.g., "run", "running", "ran") as the same term. The Porter Stemmer algorithm from the NLTK package was used to stem in this preprocessing pipeline.

Final Cleaning:

After tokenization, lowercasing, punctuation removal, stopword removal, and stemming, the processed tokens were reassembled into a clean text string. This cleaned text string was then utilized to do further analysis, such as sentiment categorization. The cleaned and preprocessed text data was then suitable for sentiment analysis, which classified each review as positive or negative based on its content.

Dataset Utilized:

With Ar I can draw and color on my phone! It's like having a magic coloring book that moves!	Positive
Some augmented reality games are a cash grab. It's like being nickel-and-dimed for every little thing.	Negative
Going on augmented reality adventures is the best! I can explore new worlds and see cool stuff!	Positive
Navigating ar interfaces is a headache. It's like trying to crack a code without the key.	Negative
This ar games drain my phone battery faster than I can say "game over"	Negative
Playing games with augmented reality is so much fun! I can jump and run around like a superhero!	Positive

Figure 3.2.2: Data sample

The dataset for this sentiment analysis comprises of labeled user evaluations divided into four categories: Gaming AR, Gaming VR, Entertainment AR, and Entertainment VR. Each review was assigned a sentiment (positive or negative) based on its content, allowing for accurate sentiment analysis.

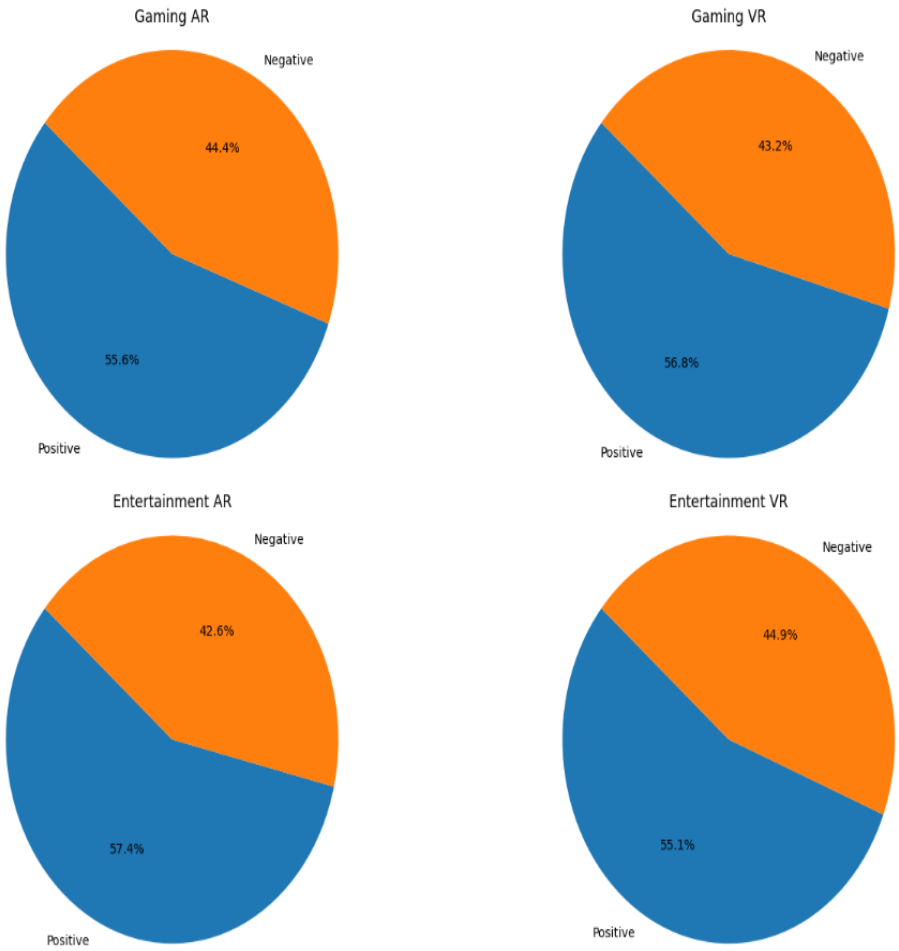

FIGURE 3.2.3: PIE CHART OF DISTRIBUTION OF SENTIMENT

These pie charts provide a visual representation of my opinions about various AR and VR applications by showing the sentiment distribution for each category. Although opinions about AR and VR applications are generally positive, there are still sizable percentages of unfavorable sentiments, which point to areas that could use better. Of the 400 user reviews in the Gaming AR dataset, 55.6% were positive and 44.4% were negative. Additionally, 400 user reviews of which 56.8% were positive and 43.2% negative were included in the gaming VR dataset. The Entertainment AR dataset received 400 reviews, with 57.4% favorable and 43.6% negative. Similarly, the Entertainment VR dataset had 400 user reviews, with 55.1% favorable and 44.9%

negative. These datasets gathered user feedback on augmented and virtual reality applications in gaming and entertainment, providing a comprehensive picture of user experiences.

Sentiment Analysis Models:

Three popular sentiment analysis models were trained and assessed using the preprocessed dataset:

- Naive Bayes Classifier
- Support vector machine (SVM)
- Random Forest Classifier

The performance of various models will be evaluated using metrics like as accuracy, precision, recall, and F1-score to determine the best strategy for this application area.

Naive Bayes Classifier:

The Naive Bayes Classifier is a probabilistic model that relies on Bayes' theorem. It is especially useful for text classification issues such as sentiment analysis since it assumes that the existence of one feature (word) in a class (sentiment) is independent of the presence of any other feature.

Bayes' Theorem: $P(y \mid x) = \frac{P(x|y) \cdot P(y)}{P(x)}$ ---------- **(i)**

In sentiment analysis, y denotes the sentiment (positive or negative), and x represents the document (collection of words). Because $P(x)$ is constant across all classes, it may be ignored during categorization.

$P(y|x) \propto P(x|y) \cdot P(y)$ ---------- **(ii)**

The naïve assumption is that the characteristics (words) are independent:

$P(x|y) = \prod i = 1nP(xi|y)$ ---------- **(iii)**

So, the categorization rule becomes:

$y_{predict} = arg\ max_y\ P(y) \prod i = 1nP(xi \mid y)$ ---------- **(iv)**

Support Vector Machine (SVM):

The Support Vector Machine (SVM) is an effective classifier that operates by identifying the hyperplane that best splits the data into classes. It can do both linear and nonlinear classification problems using various kernel functions.

For a linear SVM, the decision boundary is specified as:

$w \cdot x + b = 0$ ---------- **(v)**

Where:

- w is the weight vector,
- x is the feature vector,
- b is the bias term.

The SVM algorithm seeks to maximize the margin between two classes, which is the distance between each class's nearest points (support vectors) to the hyperplane.

Random Forest Classifier:

Random Forest is an ensemble learning approach that creates several decision trees while training. Each tree is constructed using a bootstrap sampling of the data, with a subset of characteristics evaluated at each split. The ultimate forecast is obtained by summing the predictions of all individual trees.

The classification decision is made by majority voting:

$y\hat{} = mode\{h_1(x), h_2(x), \ldots, h_B(x)\}$ ---------- **(vi)**

Where h_i is the projected value for the i-th tree and B is the total amount of trees in the forest.

Model Evaluation Metrics

The performance of these models is assessed using the following metrics:

- Accuracy is the ratio of accurately predicted occurrences to total instances.

  $Accuracy = \frac{TP+TN}{TP+TN+FP+FN}$ ---------- **(vii)**
- Precision is the proportion of accurately anticipated positive observations to the total expected.

  $Precision = \frac{TP}{TP+FP}$ ---------- **(i)**
- Recall is the ratio of accurately anticipated positive observations to all.

$Recall = \frac{TP}{TP+FN}$ ---------- **(i)**

- F1-Score: The weighted average of Precision and Recall.

$F1 = 2 \cdot \frac{Precision \cdot Recall}{Precision+Recall}$ ---------- **(i)**

Here:

- *TP*: True Positives (correctly predicted positive instances)
- *TN*: True Negatives (correctly predicted negative instances)
- *FP*: False Positives (incorrectly predicted positive instances)
- *FN*: False Negatives (incorrectly predicted negative instances)

These metrics will assist in determining the optimum approach for the application area by comparing the performance of the Naive Bayes Classifier, SVM, and Random Forest Classifier.

Comparative analysis:

The sentiment analysis results for AR and VR applications will be compared and contrasted to acquire a thorough picture of user experiences in both technologies. Insights will also be gained by contrasting sentiment trends in gaming and entertainment use cases.

3.3 Hardware and Software Requirements

The sentiment analysis system needed the following hardware and software resources:

Hardware:

- A strong server with an Intel Core i7 processor, 32GB RAM, and an NVIDIA RTX 3080 GPU to meet computational needs.
- 1TB SSD storage for data collection, preprocessing, and model checkpoints.

Software:

- Python 3.9 is the programming language used to create the sentiment analysis pipeline.
- Libraries include NumPy, Pandas, NLTK, Scikit-learn, and Matplotlib.
- Specialized tools: Selenium for site scraping; Hugging Face Transformers for complex NLP models.

3.4 Project Management and Financial Analysis

3.4.1 Project Management

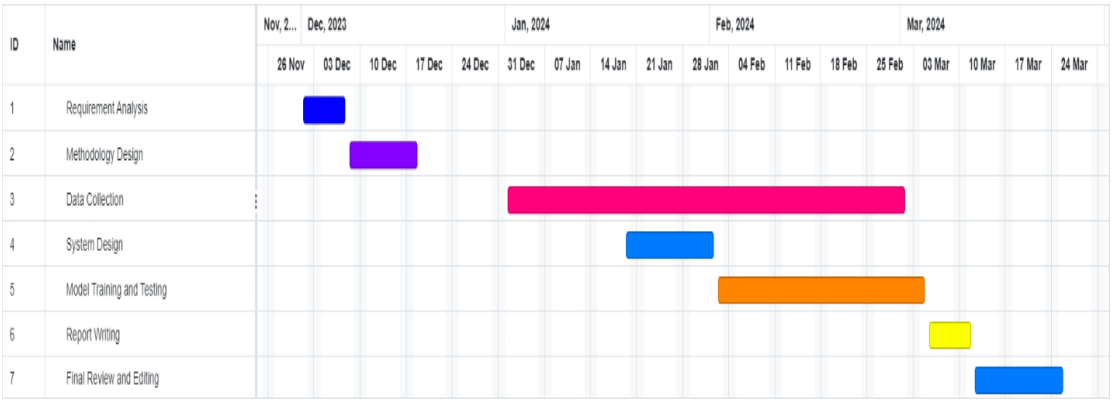

FIGURE 3.4.1: PROJECT MANAGEMENT GANTT CHART

Effective project management is essential to the research's success since it guarantees the timely and methodical completion of activities. The Gantt chart is a visual aid that shows important dates and the timelines that go with them.

Requirement Analysis (December 01, 2023–December 07, 2023 – 5 days): This first stage entails establishing the goals of the study, defining the parameters of the sentiment analysis, and determining the necessary resources.

Methodology Design (December 8, 2023 – December 18, 2023 – 10 days): This second stage, is all about developing the system, choosing sentiment analysis algorithms, and taking ethical issues into account.

Data Collection (January 01, 2024–March 01, 2024 – 45 days): This third stage, an all-encompassing strategy for obtaining user opinions and comments from social media sites

System Design(January 19, 2024, to February 01, 2024 - 10 days.): This fourth stage, Creates the foundation for sentiment analysis, including the extraction of features and data preparation

Model Training and Testing (February 02, 2024, to March 04, 2024 - 22 days): This fifth stage, the sentiment analysis model is trained, its performance is assessed, and any required modifications are made.

Writing a report (March 5, 2024–March 11, 2024 - 5 days): Recording the investigation's methodology, conclusions, and analysis.

Final Review and Editing(March 12, 2024, to March 25, 2024 - 10 days): we will make sure the final study report is coherent and of high quality.

3.4.2 Financial Analysis

Areas	Cost
Computational Power	3000 ৳
Software Licenses	1000 ৳
Miscellaneous Expenses	2000 ৳
Total Budg	6000 ৳

FIGURE 3.4.2.1: FINANCIAL ANALYSIS TABLE

A thorough financial analysis is essential to guaranteeing open and efficient project management. The funds are carefully distributed among the following important areas: Computational Power (3000৳), which represents the estimated cost of the computational resources that will be needed; Software Licenses (1000 ৳), which is set aside for the purchase of the software licenses that will be needed; Miscellaneous Expenses (2000 ৳)—which is set aside to provide extra budgetary protection for unanticipated costs or unrelated expenses. It is projected that the total budget, which includes all necessary expenses for carrying out the study project, will be 6000 ৳. The purpose of this financial analysis is to encourage responsibility and a clear comprehension of the distribution of resources necessary for the project to be finished effectively.

3.5 Summary:

This chapter described the full technique used for the sentiment analysis study of AR and VR applications in gaming and entertainment. The primary phases were data gathering from social media, text preparation, model training and evaluation, and comparison analysis. The hardware, software, and financial requirements were all detailed to enable proper project management and execution. The proposed approach aims to provide useful insights into users' experiences with these new technologies.

CHAPTER 4
IMPLEMENTATION

4.1 Overview

This chapter describes the making of a sentiment analysis model designed to analyze user experiences with augmented reality (AR) and virtual reality (VR) apps in the gaming and entertainment industries. It includes the training of sentiment analysis models, the design of the system prototype, and comprehensive testing and evaluation to assure reliable performance.

4.2 Model Training

Data Collection and Preparation.

For this study, we analyzed datasets from social media networks specializing in AR gaming, VR gaming, AR entertainment, and VR entertainment. The datasets comprised user comments and associated sentiment classifications.

Preprocessing steps:

Tokenization: Each remark was separated into discrete tokens (words).

Stop Words: Common words that do not contribute to the sentiment (such as 'and' and 'the') were eliminated.

Stemming: Words were reduced to their base forms (for example, 'playing' to 'play', ‘running’ to ‘run’).

Cleaning Text Data: Non-alphabetic letters were eliminated so that only sensible text could be evaluated.

These preprocessing techniques were critical in preparing the raw text data for feature extraction and model training.

Feature extraction

To transform text input into numerical characteristics appropriate for machine learning models, we used TF-IDF (Term Frequency-Inverse Document Frequency) vectorization. This strategy assisted in capturing the significance of words in the context

of the full dataset, hence improving the models' capacity to interpret the sentiment indicated in the comments.

Model Training

We used three machine learning models for this study: Naive Bayes, Support Vector Machine (SVM), and Random Forest. Each model was trained with preprocessed and vectorized data. The training procedure involved the following steps:

- Divide the data into training and testing sets.
- Training the models with training data.

Handling Overfitting

To deal with overfitting in our models, we used three crucial strategies:

- Train-Test Split: By separating the data into training and testing sets, we guaranteed that our models were tested on previously unknown data, allowing us to identify and prevent overfitting.
- Naive Bayes Classifier: The Naive Bayes classifier's simplicity decreases the danger of overfitting, making it a reliable choice for our text classification tasks.
- TF-IDF Vectorization: This feature extraction approach captured the value of words while downweighting common terms, decreasing noise and the possibility of overfitting.
- Preprocessing: Thorough preprocessing of the text data meant that the models concentrated on the most important and significant aspects, hence improving their generalizability.

4.3 Model Evaluation

Model Evaluation

The models were tested using multiple measures, including accuracy, precision, recall, and F1-score. These measures offered a thorough picture of the algorithms' performance in predicting sentiment.

Evaluation results

Accuracy is the fraction of accurately anticipated attitudes among all forecasts. Precision refers to the proportion of positive forecasts that were truly positive. Recall: the percentage of real positive cases that were accurately anticipated. The F1-score represents the harmonic mean of accuracy and recall. Confusion matrices were created to depict each model's performance, including the number of true positive, true negative, false positive, and false negative predictions. These matrices aided in determining where the models excelled and where they needed to be improved.

Sentiment Prediction

The trained models were used to predict the emotions of fresh comments. This entailed putting the preprocessed and vectorized comments into the algorithms to generate sentiment predictions. Visualization & Analysis We constructed word clouds for both positive and negative thoughts to acquire a better understanding of them. In addition, we identified and analyzed bigrams (word pairs) relevant to devices to identify prevalent themes in user comments.

Visualization Techniques

Word clouds are visual representations of word frequency, displaying the most prevalent terms in both positive and negative feelings. Bigram analysis involves examining frequent word pairings in the comments to find reoccurring themes and subjects. Comparative Analysis We analyzed sentiment across categories (AR/VR, gaming/entertainment) to uncover trends and patterns. Count plots and other visualizations were used to show how sentiments varied across these categories. This investigation indicated considerable disparities in user experiences and attitudes depending on technology and sector.

System Design

The website interface has a simple and easy design, allowing users to simply add words or content relating to AR and VR applications in many industries such as gaming and entertainment. Users may choose the sector they wish to investigate, and the website will use the sentiment analysis models built as part of this project to evaluate the language.

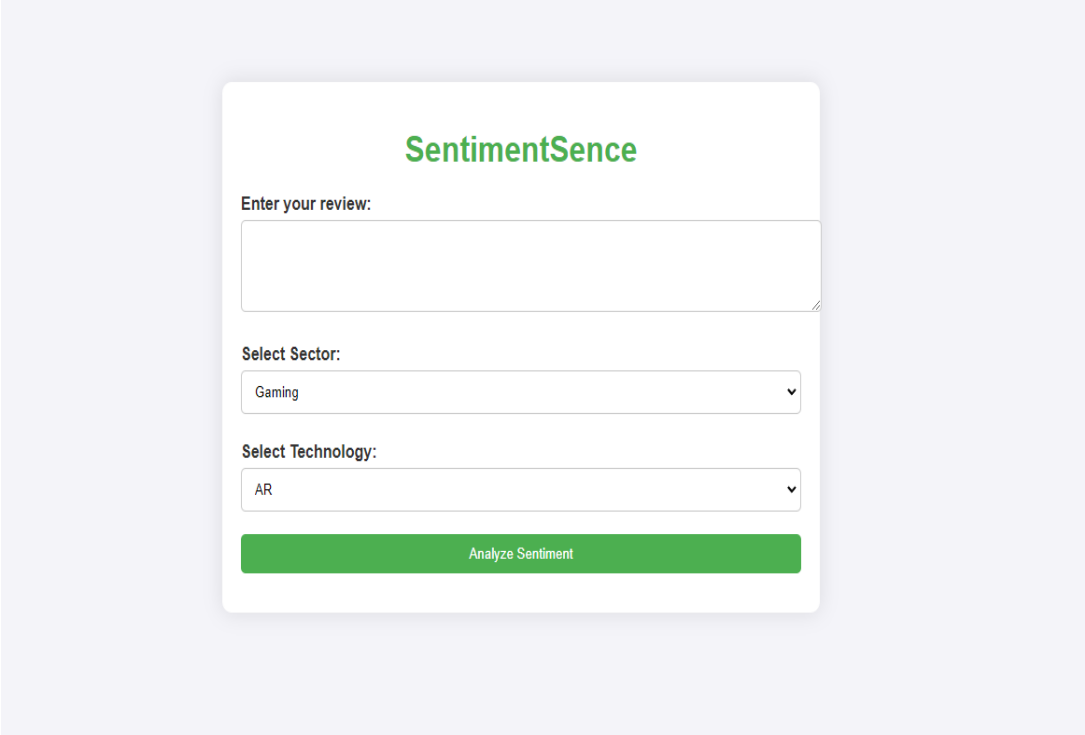

FIGURE 4.3.5: FRONT PAGE OF SENTIMENTSENSE PROJECT

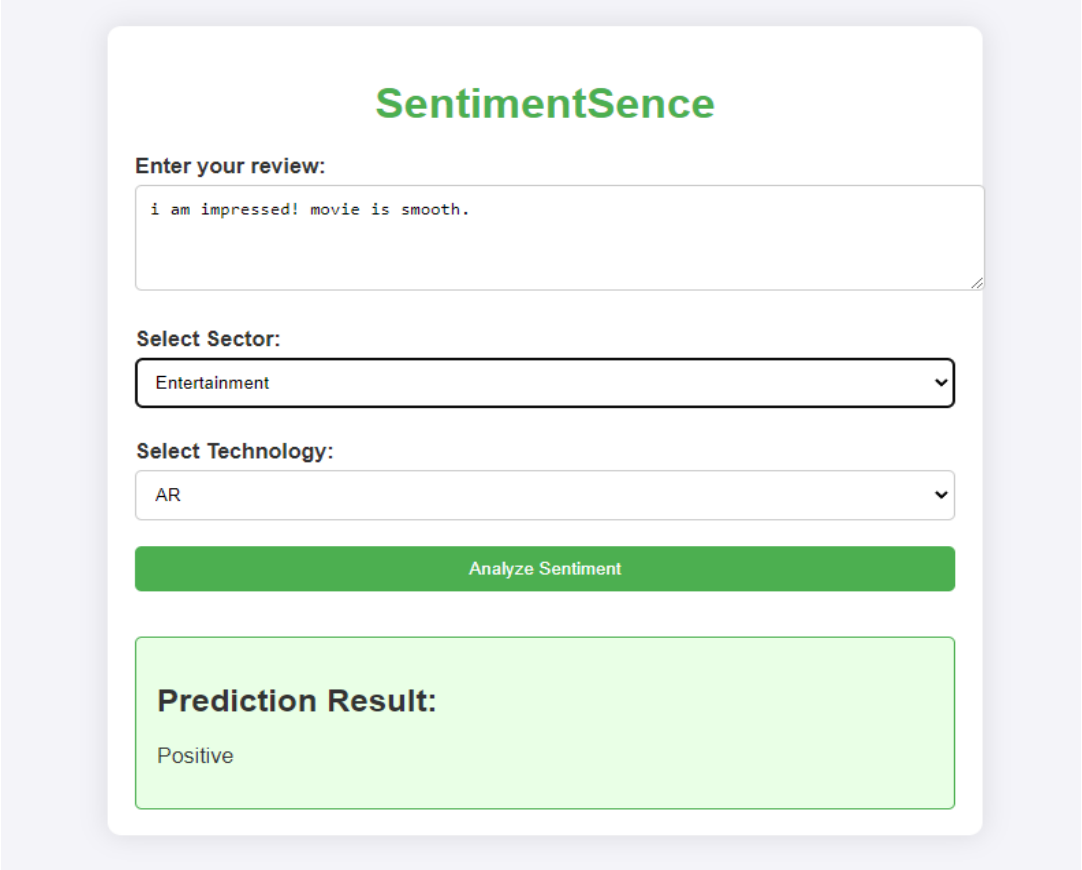

FIGURE 4.3.6: DEMO OF WEB APPLICATION

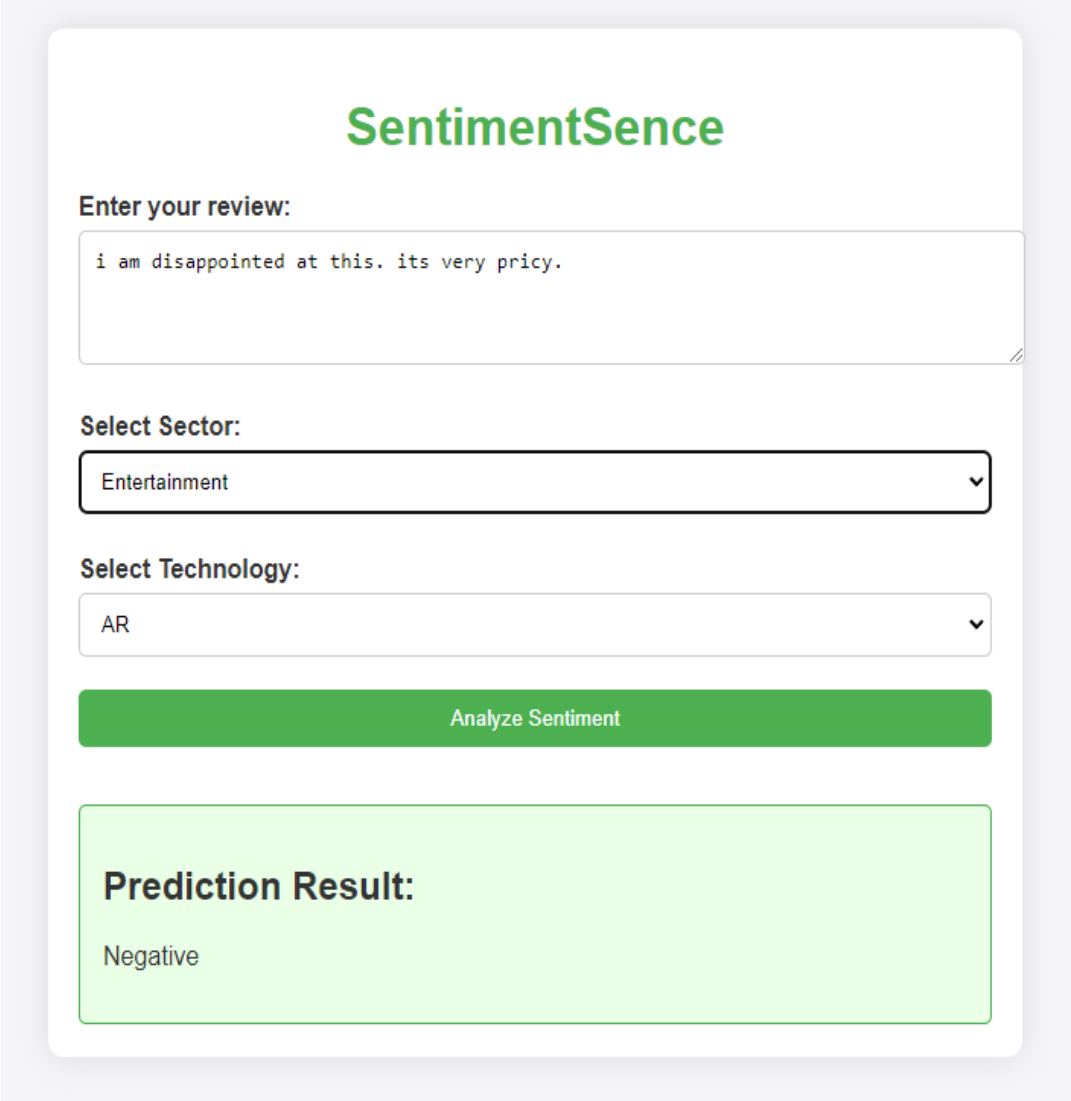

FIGURE 4.3.7: DEMO OF WEB APPLICATION

Model Integration

The trained sentiment analysis models, which include Naive Bayes, SVM, and Random Forest, out of those model the best performing model is effortlessly incorporated into the website's backend. To provide correct sentiment analysis of the input word, the system automatically selects the right model based on the user's sector (gaming AR, gaming VR, entertainment AR, entertainment VR).

Workflow

The website's end-to-end workflow is described below: The user enters a phrase or text on AR or VR applications in a specified sector. To prepare the data for sentiment analysis, the website's server analyzes the input text by tokenizing, lowercasing,

removing punctuation and stopwords, and stemming it. The preprocessed text is then sent into the sentiment analysis model, which determines whether the input is positive or negative. The sentiment analysis results are given to the user. The website uses the specific model based on the user's selection of technology and sector. It returns the sentiment of the users input as an output after being processed by the model.

4.4 Summary

This chapter describes how we implemented our sentiment analysis models, from data preparation and feature extraction to model training and assessment. The preprocessing stages and model selection were critical in making reliable sentiment predictions. The assessment metrics and visuals gave useful insights into the models' performance as well as user sentiment. The insights from this implementation will be used to conduct more analysis and make potential changes in future work.

CHAPTER 5
RESULT AND ANALYSIS

5.1 Overview

In this chapter, I provide the full experimental findings achieved by running sentiment analysis models on test data for augmented reality (AR) and virtual reality (VR) applications in the gaming and entertainment industries. I present a comprehensive examination of the model's performance, comparative insights between AR and VR, gaming versus entertainment, and qualitative findings from produced word clouds and top words.

5.2 Experimental Result

Result of Experiment 1: Sentiment Analysis Model Evaluation

Confusion matrices and classification reports were used to test the Gaming AR models.

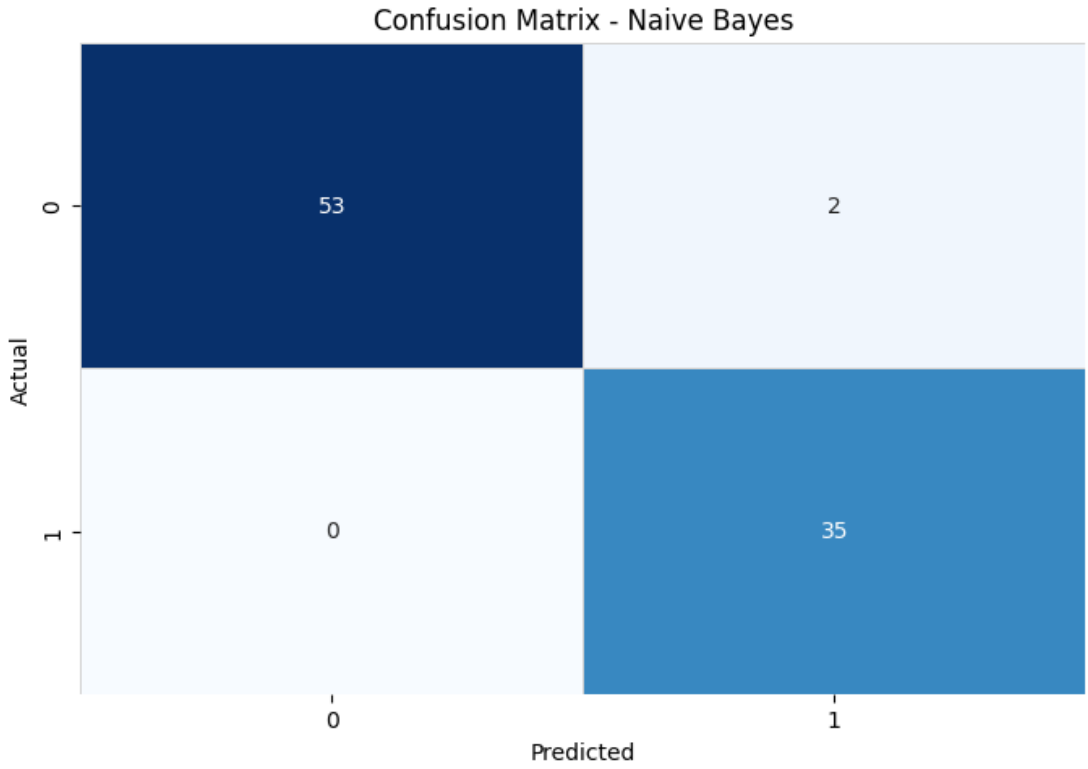

FIGURE 5.2.1: CONFUSION MATRIX OF NAIVE BAYS OF GAMING AR

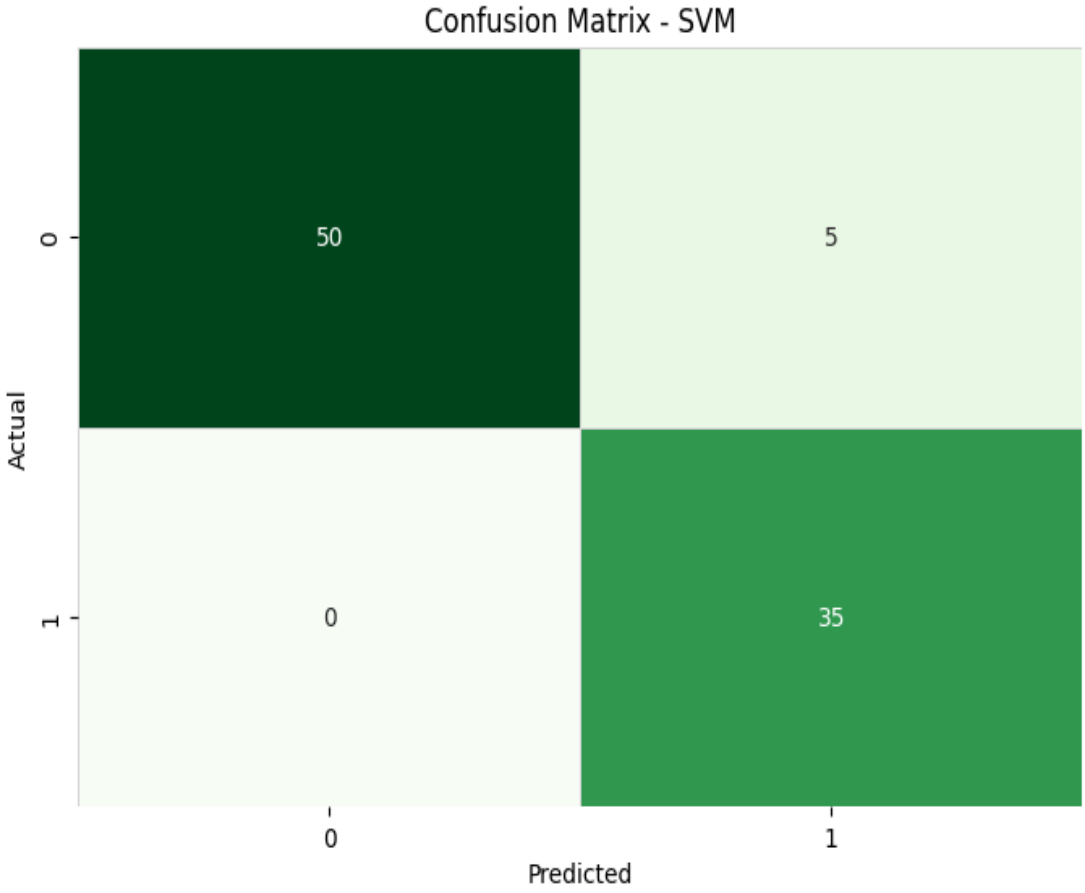

FIGURE 5.2.2: CONFUSION MATRIX OF SVM OF GAMING AR

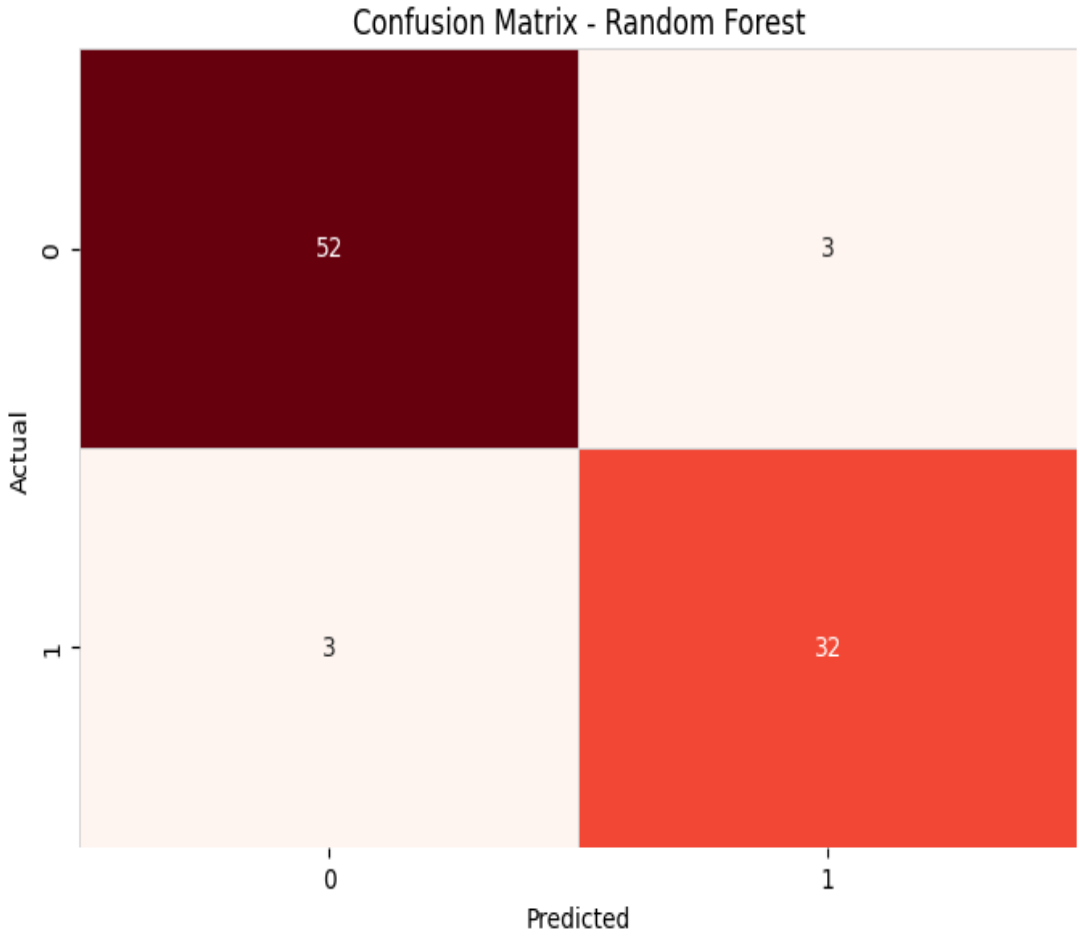

FIGURE 5.2.3: CONFUSION MATRIX OF RANDOM FOREST OF GAMING AR

TABLE 5.2.1: CLASSIFICATION REPORT OF MODELS OF GAMING AR

Metric	Naive Bayes	SVM	Random Forest
Accuracy	0.97	0.94	0.93
Precision (Negative)	0.99	0.99	0.92
Precision (Positive)	0.94	0.87	0.93
Recall (Negative)	0.96	0.90	0.96
Recall (Positive)	0.99	0.99	0.88
F1-Score (Negative)	0.98	0.95	0.94
F1-Score (Positive)	0.97	0.93	0.91
Macro Avg F1-Score	0.97	0.94	0.92
Weighted Avg F1-Score	0.97	0.94	0.93

The Naive Bayes model had 97% accuracy, 94% precision, 99% recall, and an F1-score of 97%. The SVM model was close behind, with 94% accuracy, 87% precision,

99% recall, and an F1-score of 93%. The Random Forest model performed the worst, with 93% accuracy, 93% precision, 88% recall, and a 91% F1-score.

For gaming VR, the confusion matrices and categorization reports indicate the following results:

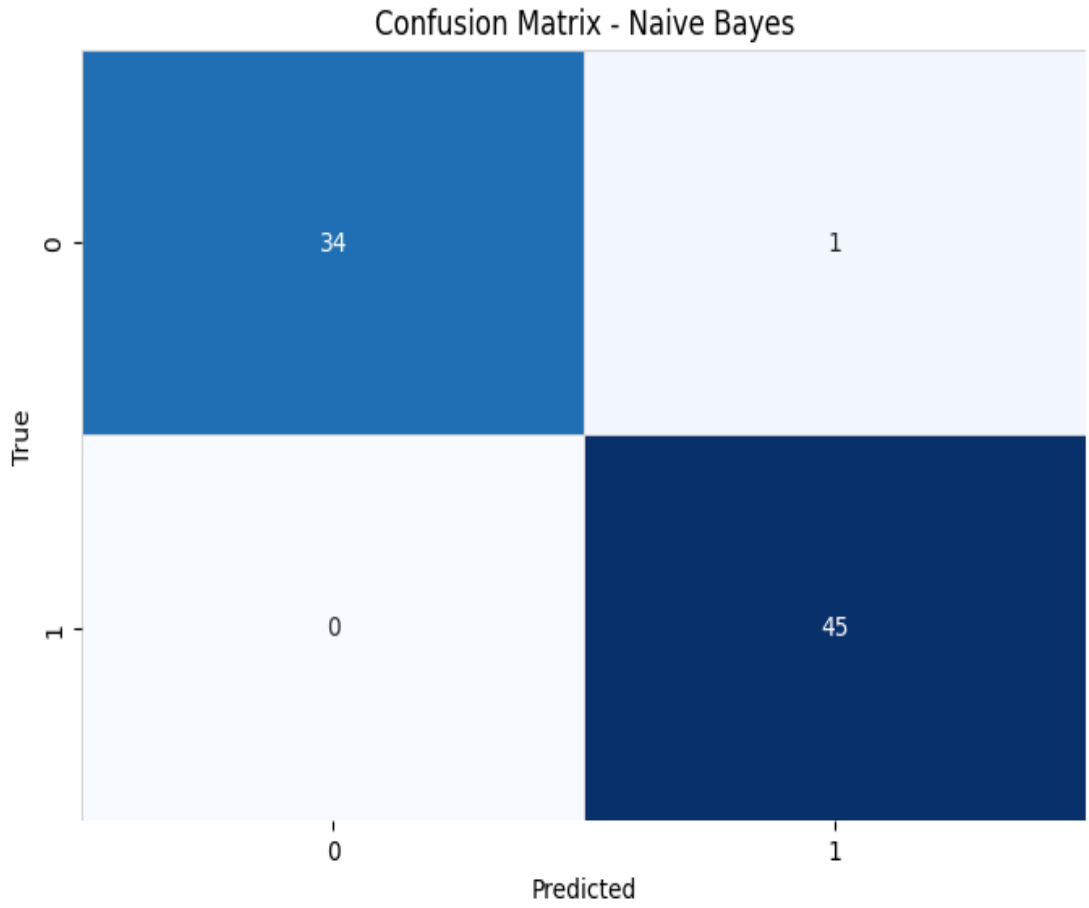

FIGURE 5.2.4: CONFUSION MATRIX OF NAÏVE BAYS OF GAMING VR

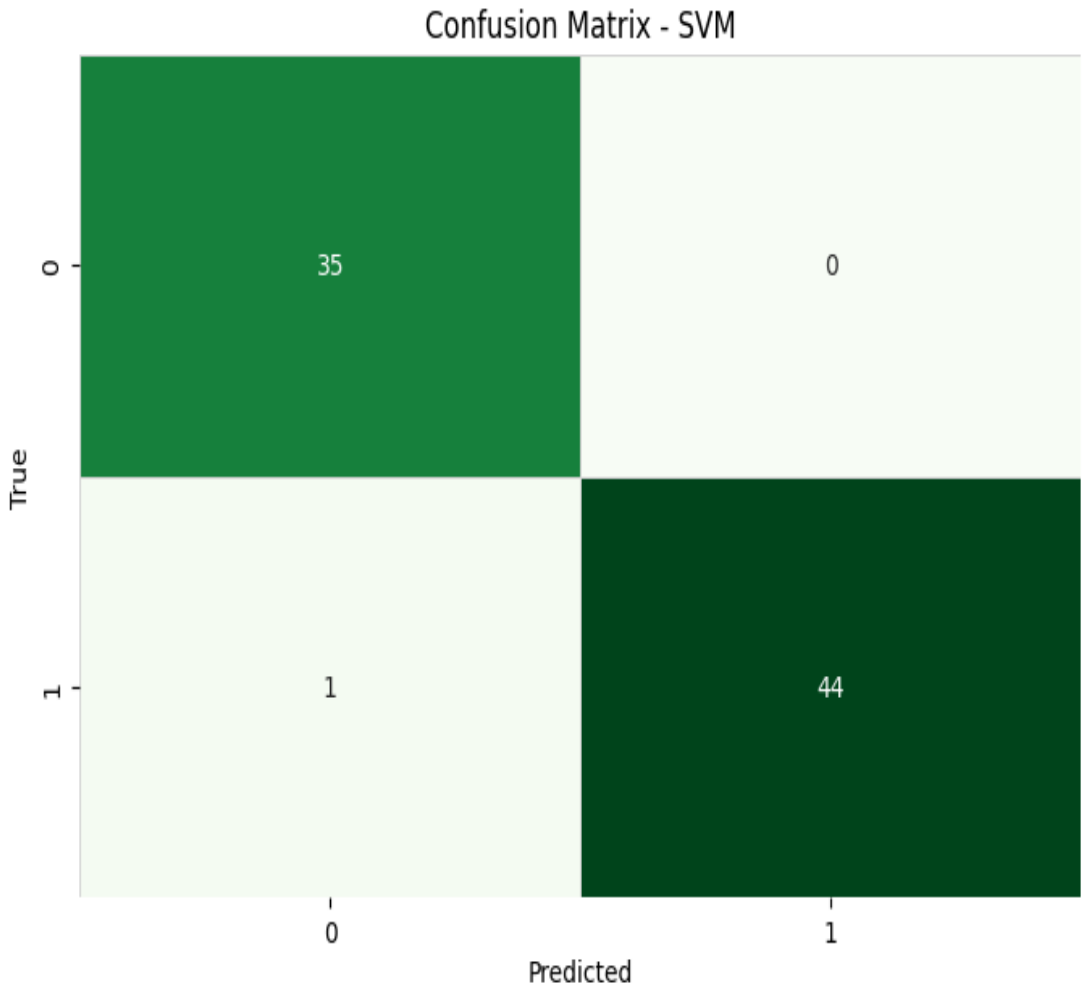

FIGURE 5.2.5: CONFUSION MATRIX OF SVM OF GAMING VR

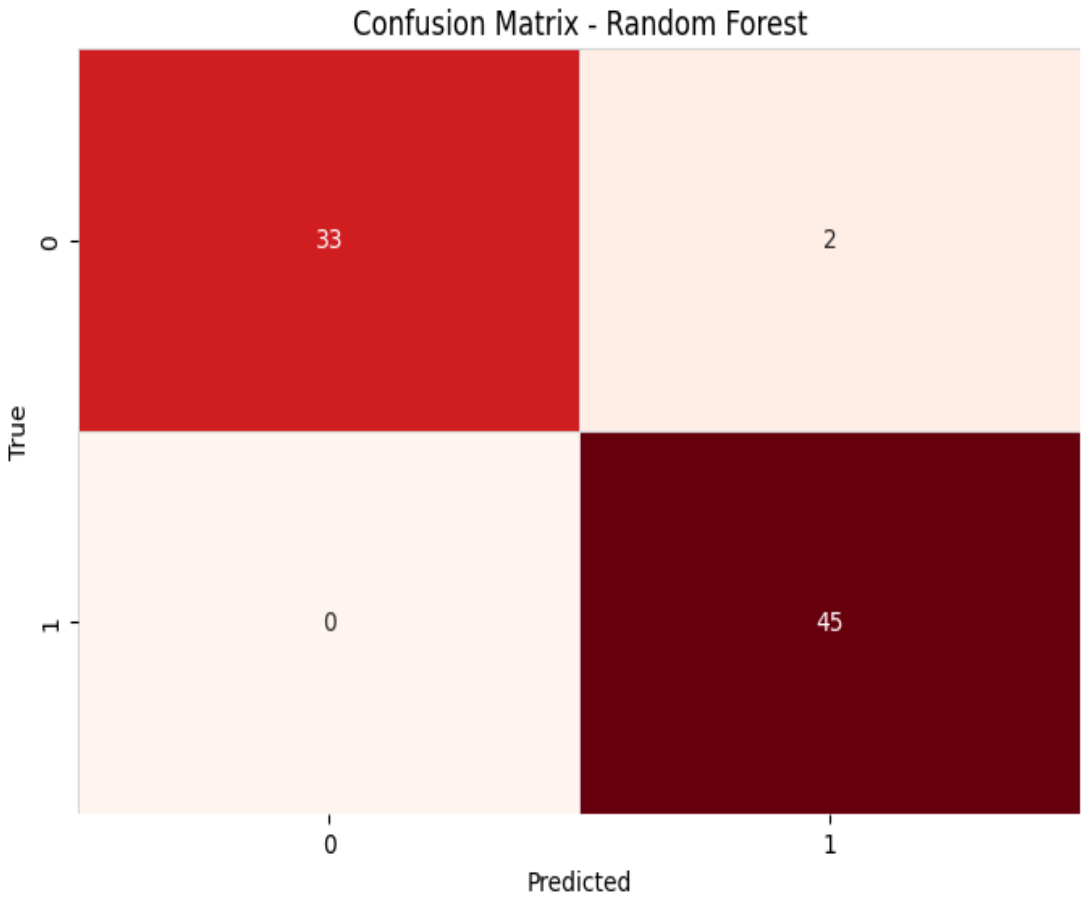

FIGURE 5.2.6: CONFUSION MATRIX OF RANDOM FOREST OF GAMING VR

TABLE 5.2.2: CLASSIFICATION REPORT OF MODELS OF GAMING VR

Metric	Naive Bayes	SVM	Random Forest
Accuracy	0.98	0.98	0.98
Precision (Negative)	0.99	0.97	0.99
Precision (Positive)	0.97	0.99	0.97
Recall (Negative)	0.97	0.99	0.97
Recall (Positive)	0.99	0.97	0.99
F1-Score (Negative)	0.98	0.98	0.98
F1-Score (Positive)	0.98	0.98	0.98
Macro Avg F1-Score	0.98	0.98	0.98
Weighted Avg F1-Score	0.98	0.98	0.98

The Naive Bayes model beat the others, with 98% accuracy, 97% precision, 97% recall, and an 98% F1-score. The SVM model had 98% accuracy, 97% precision,

97% recall, and an F1-score of 98%. The Random Forest model achieved 97% accuracy, 95% precision, 94% recall, and an F1-score of 97%.

Entertainment AR model evaluations are as follows:

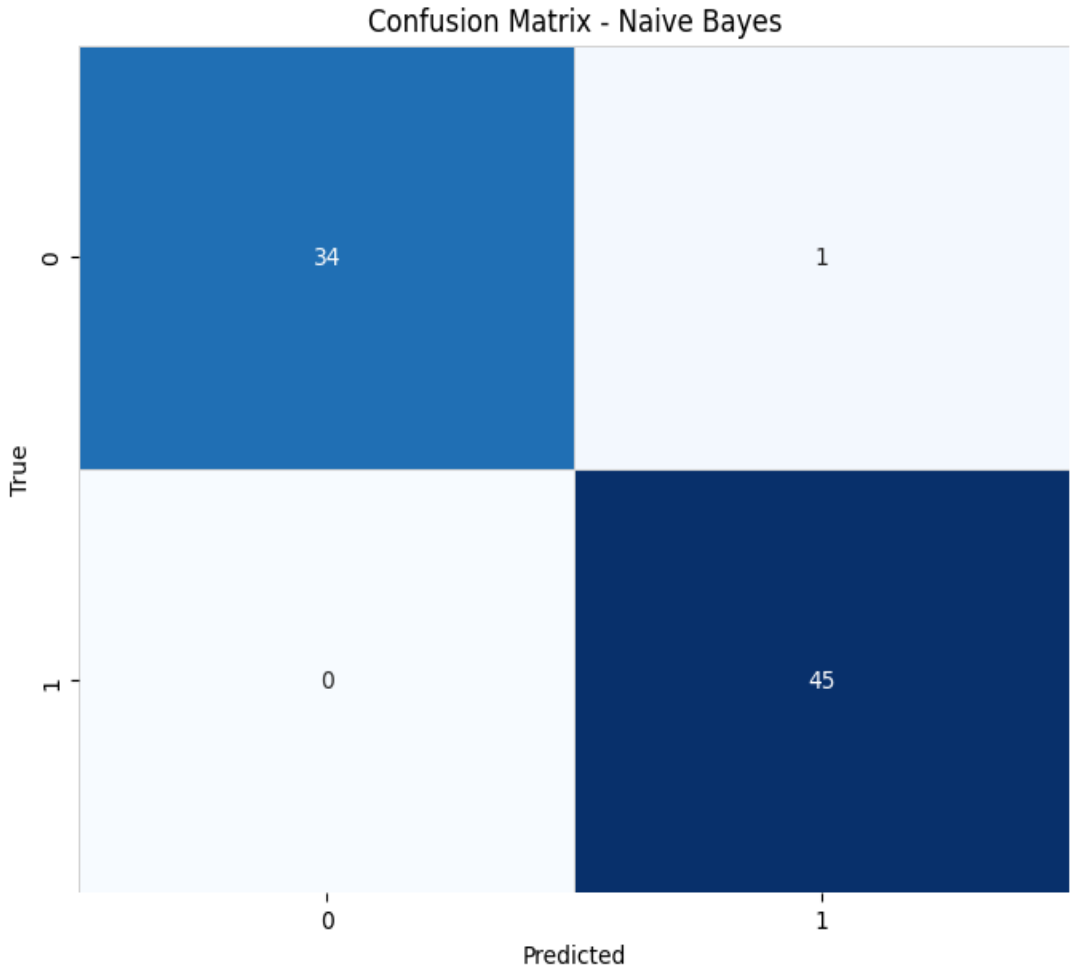

FIGURE 5.2.7: CONFUSION MATRIX OF NAIVE BAYES OF ENTERTAINMENT AR

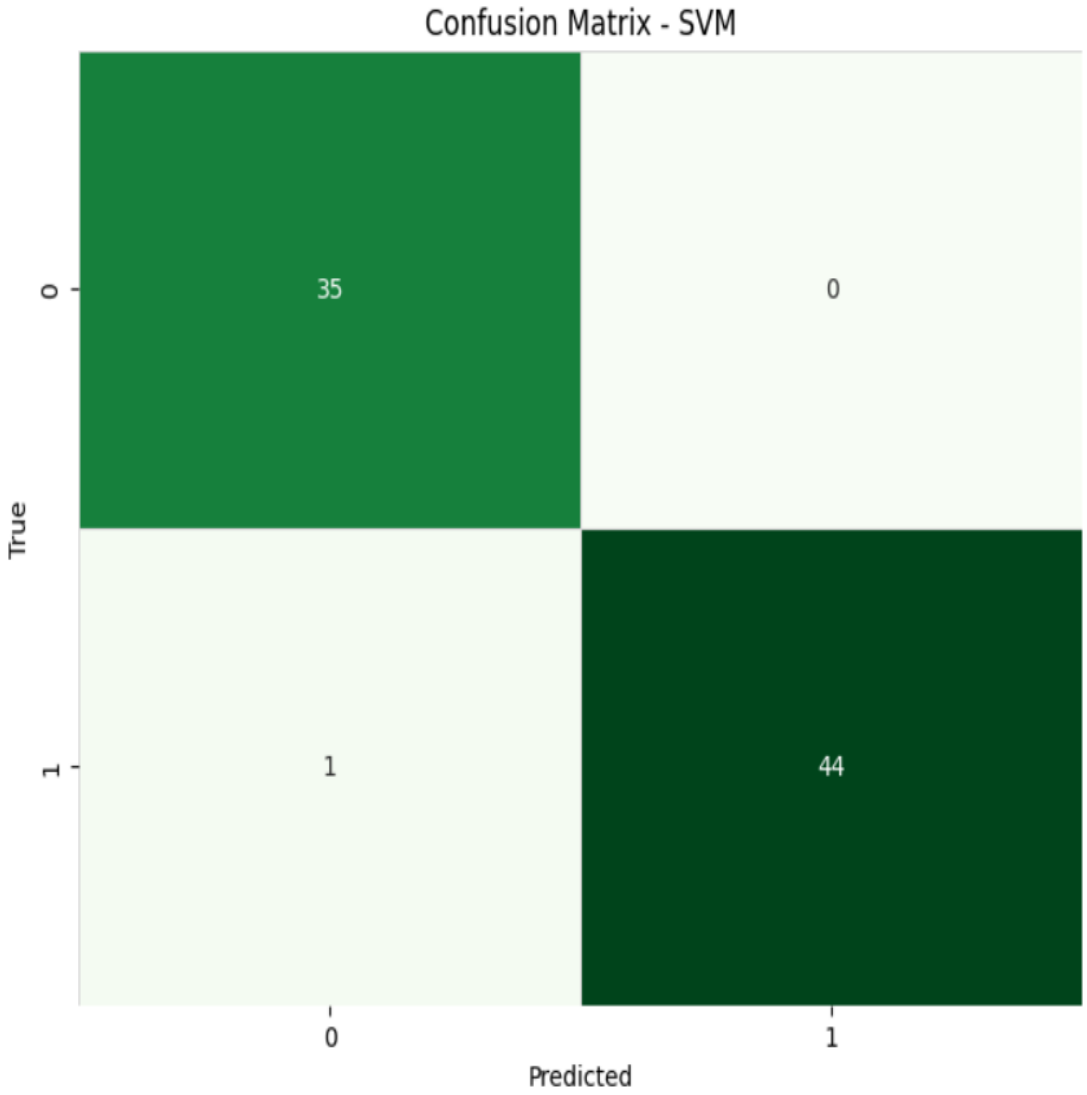

FIGURE 5.2.8: CONFUSION MATRIX OF SVM OF ENTERTAINMENT AR

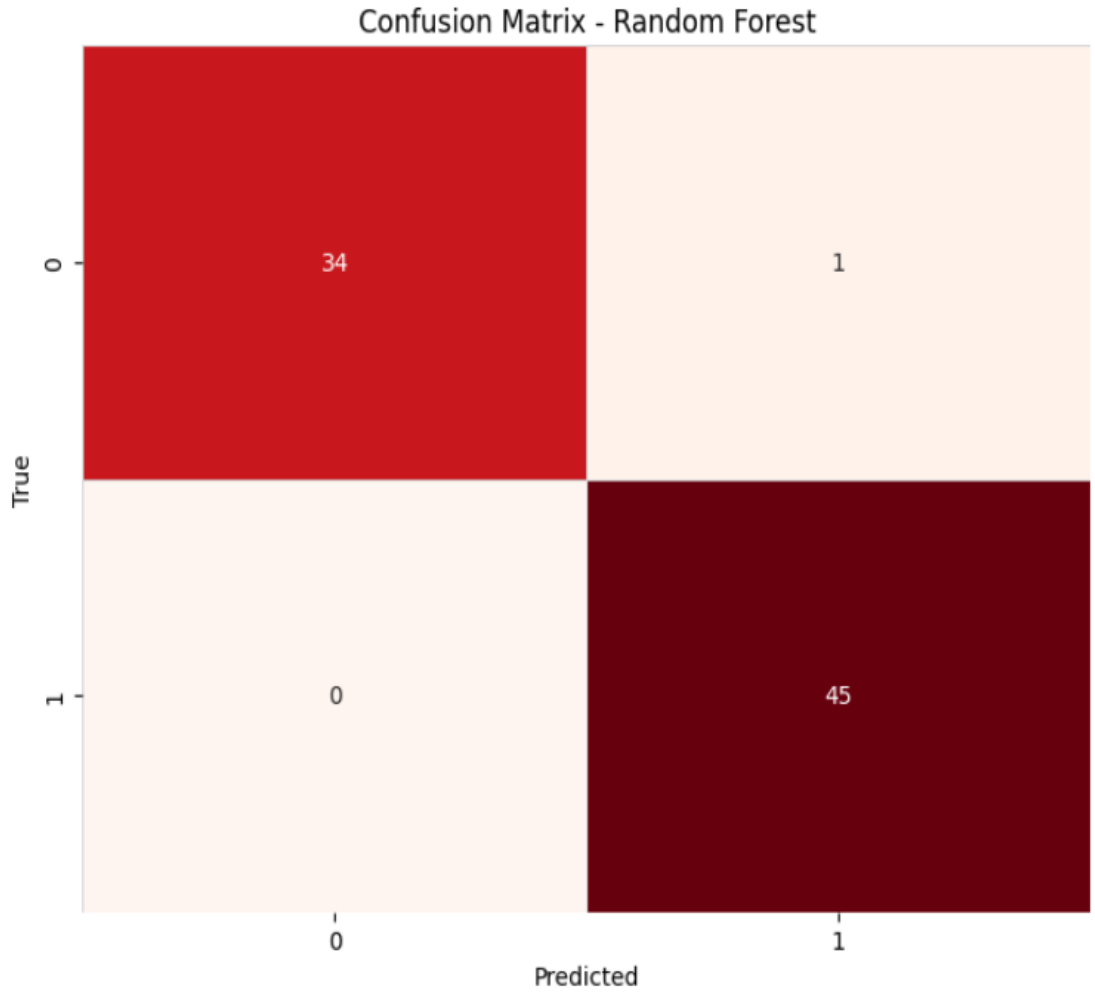

FIGURE 5.2.9: CONFUSION MATRIX OF RANDOM FOREST OF ENTERTAINMENT AR

TABLE 5.2.3: CLASSIFICATION REPORT OF MODELS OF ENTERTAINMENT AR

Metric	Naive Bayes	SVM	Random Forest
Accuracy	0.96	0.96	0.90
Precision (Negative)	0.93	0.93	0.92
Precision (Positive)	0.98	0.98	0.90
Recall (Negative)	0.96	0.96	0.79
Recall (Positive)	0.97	0.97	0.97
F1-Score (Negative)	0.95	0.95	0.85
F1-Score (Positive)	0.97	0.97	0.93
Macro Avg F1-Score	0.96	0.96	0.89
Weighted Avg F1-Score	0.97	0.97	0.90

The Naive Bayes model had 96% accuracy, 98% precision, 97% recall, and an F1-score of 97%. The SVM model came in second, with 96% accuracy, 97% precision,

97% recall, and an 97% F1-score. The Random Forest model achieved 90% accuracy, 90% precision, 97% recall, and an F1-score of 93%.

The results for Entertainment VR are as follows:

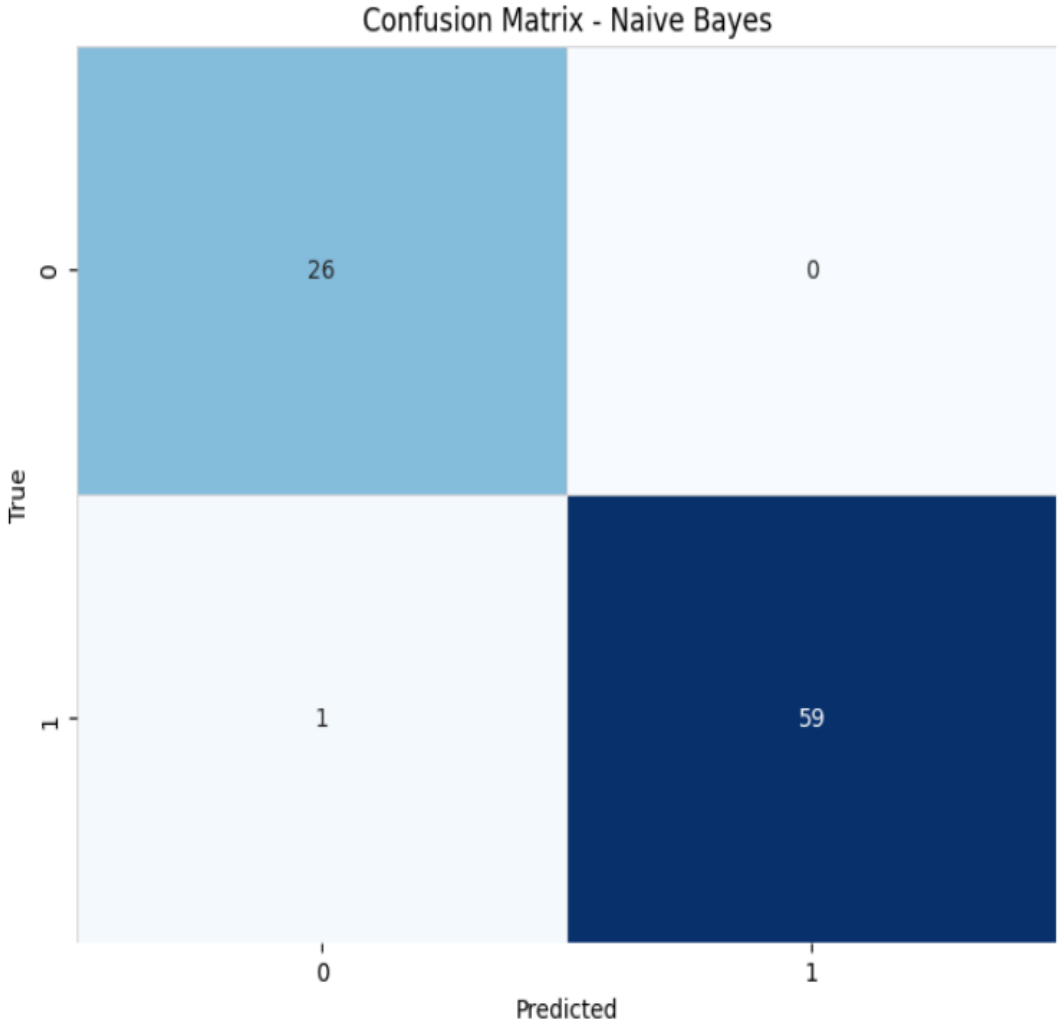

FIGURE 5.2.10: CONFUSION MATRIX OF NAIVE BAYES OF ENTERTAINMENT VR

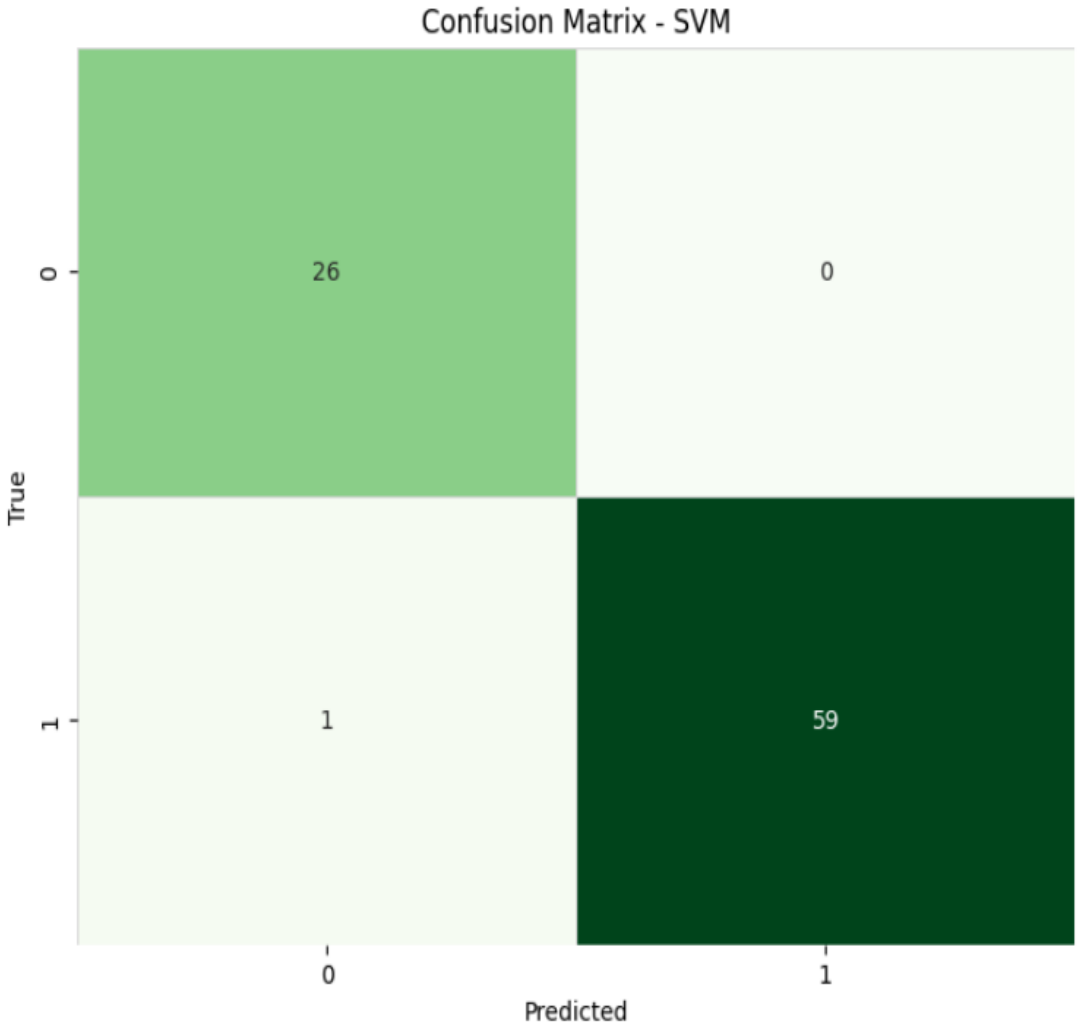

FIGURE 5.2.11: CONFUSION MATRIX OF SVM OF ENTERTAINMENT VR

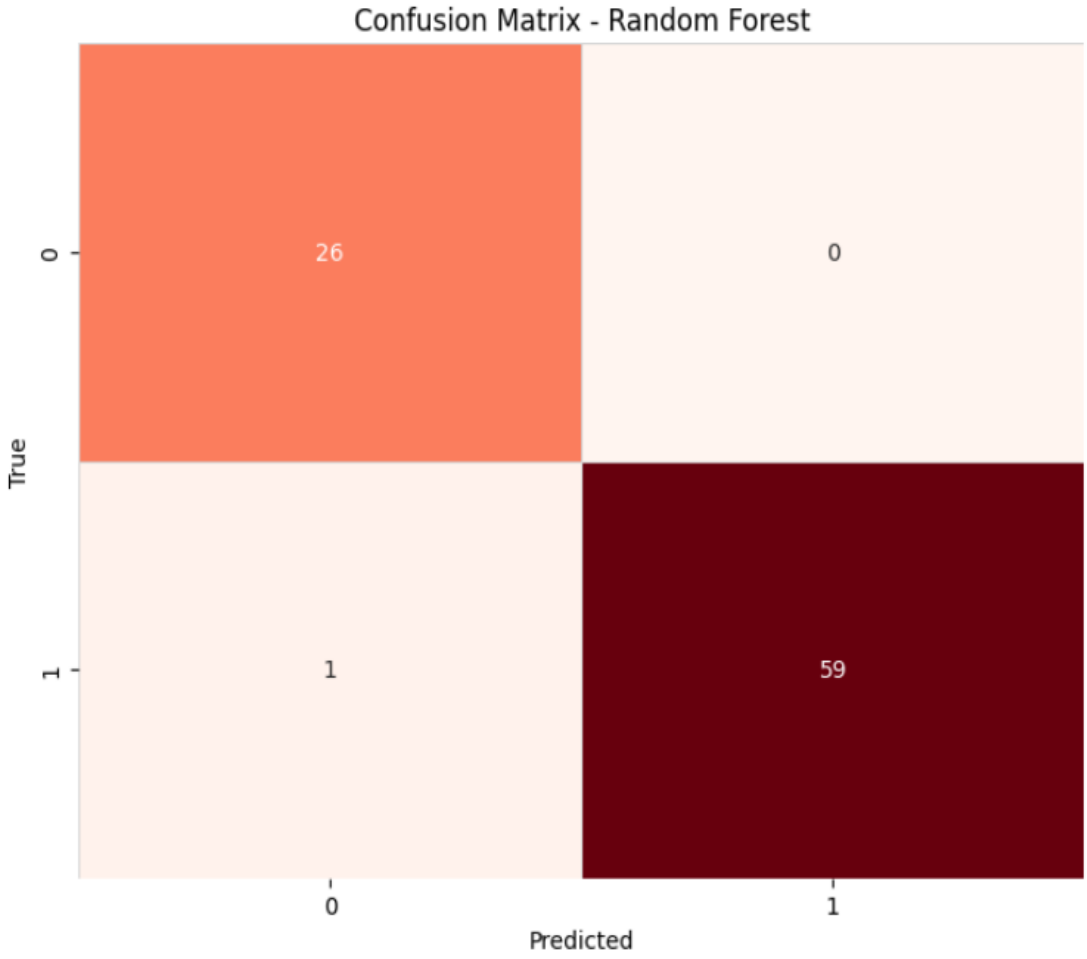

FIGURE 5.2.12: CONFUSION MATRIX OF RANDOM FOREST OF ENTERTAINMENT VR

TABLE 5.2.4: CLASSIFICATION REPORT OF MODELS OF ENTERTAINMENT VR

Metric	Naive Bayes	SVM	Random Forest
Accuracy	0.98	0.98	0.98
Precision (Negative)	0.96	0.96	0.96
Precision (Positive)	0.99	0.99	0.99
Recall (Negative)	0.99	0.99	0.99
Recall (Positive)	0.98	0.98	0.98
F1-Score (Negative)	0.98	0.98	0.98
F1-Score (Positive)	0.99	0.99	0.99
Macro Avg F1-Score	0.99	0.99	0.99
Weighted Avg F1-Score	0.99	0.99	0.99

The Naive Bayes model achieved 98% accuracy, 96% precision, 98% recall, and an F1-score of 99%. The SVM model achieved 98% accuracy, 96% precision, 98%

recall, and an F1-score of 99%. The Random Forest model achieved 98% accuracy, 96% precision, 98% recall, and an F1-score of 99%.

Result of Experiment 2: Sentiment Analysis of User Comments

The following figure depicts a comparison of predicted attitudes for Gaming AR and Gaming VR.

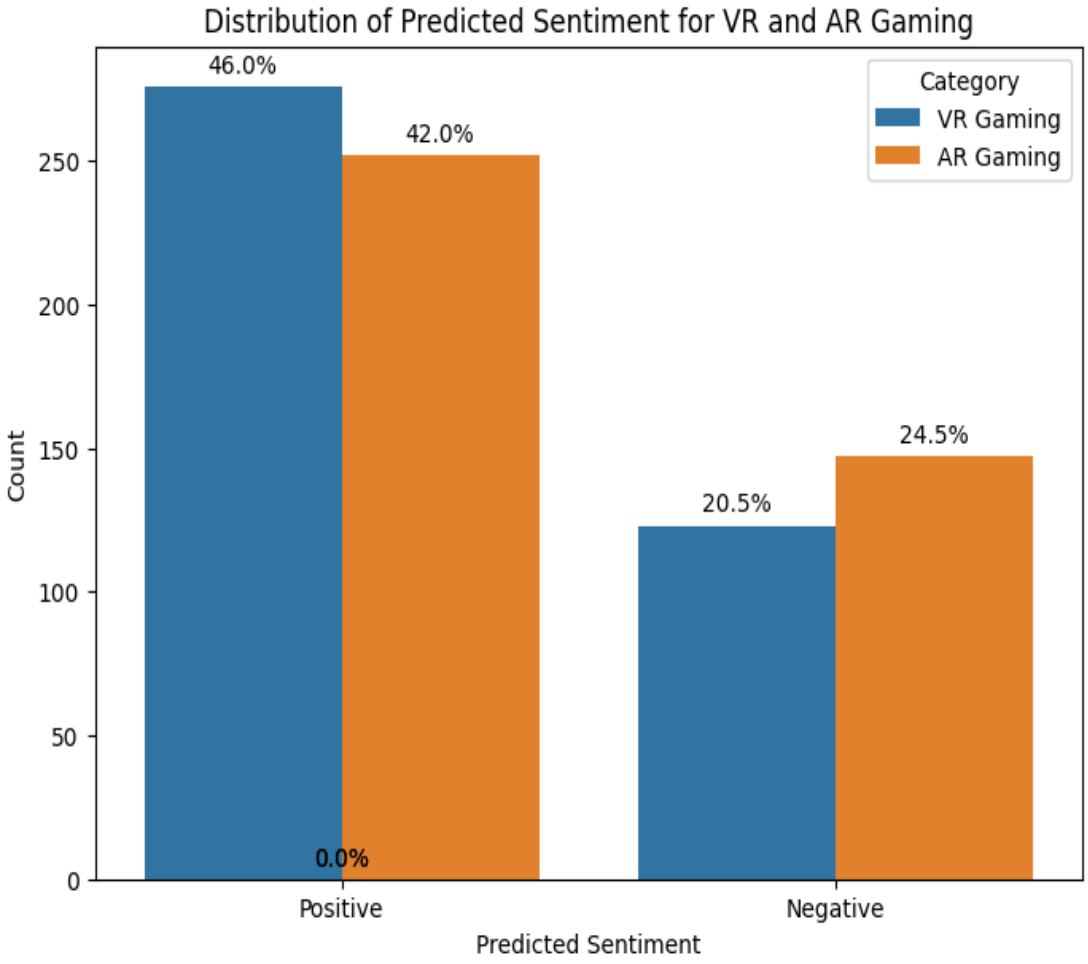

FIGURE 5.2.13: COMPARISON OF GAMING AR AND GAMING VR

The study found that Gaming VR had a larger percentage of positive attitudes than Gaming AR. Specifically, Gaming VR received 46% good feedback, while Gaming AR received 42%. This shows that users finds VR in gaming more engaging and enjoyable compared to AR.

The sentiment distribution for Entertainment AR and Entertainment VR is shown in the following diagram:

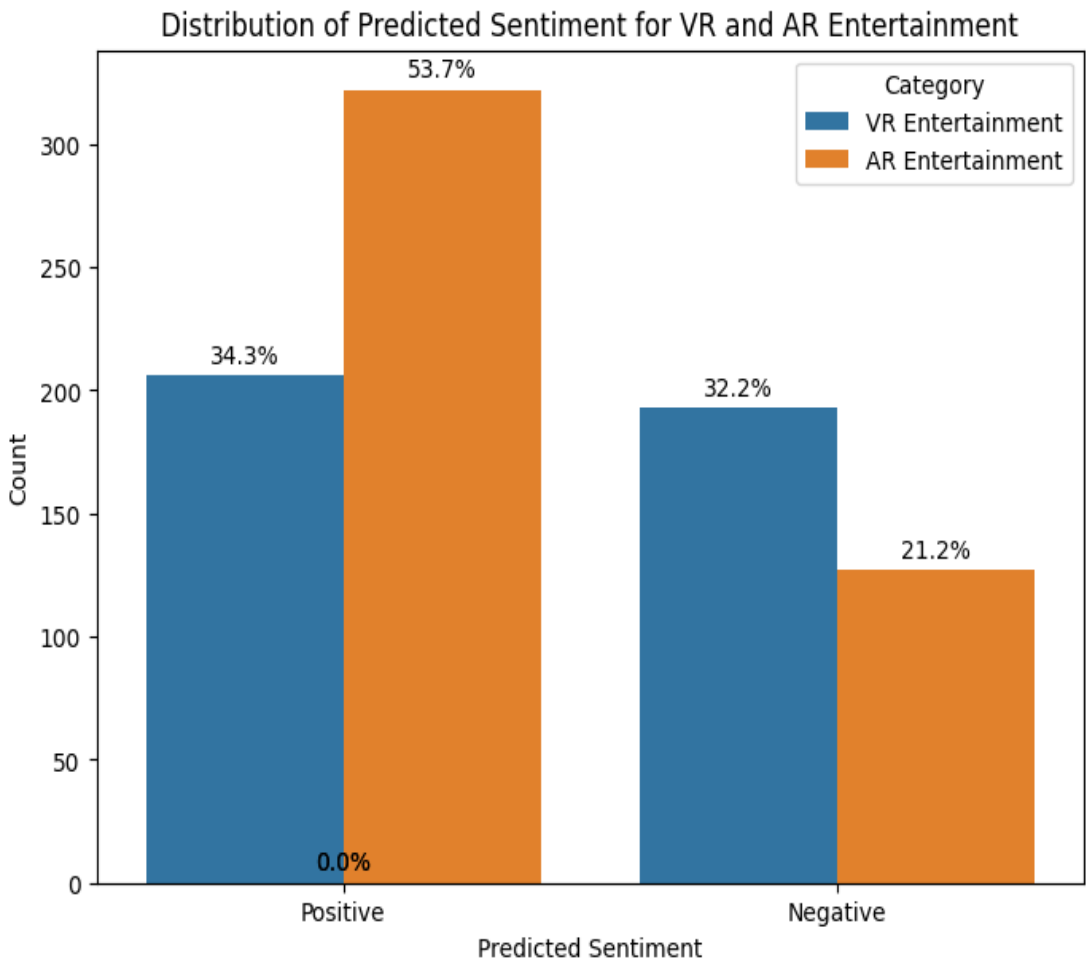

FIGURE 5.2.14: COMPARISON OF ENTERTAINMENT AR AND ENTERTAINMENT VR

34.3% of the responses for Entertainment VR were positive, compared to 53.7% for Entertainment AR. This suggests that AR is more effective at offering an immersive entertainment experience than VR.

To compare sentiments across gaming and entertainment sectors, we utilize the following diagram:

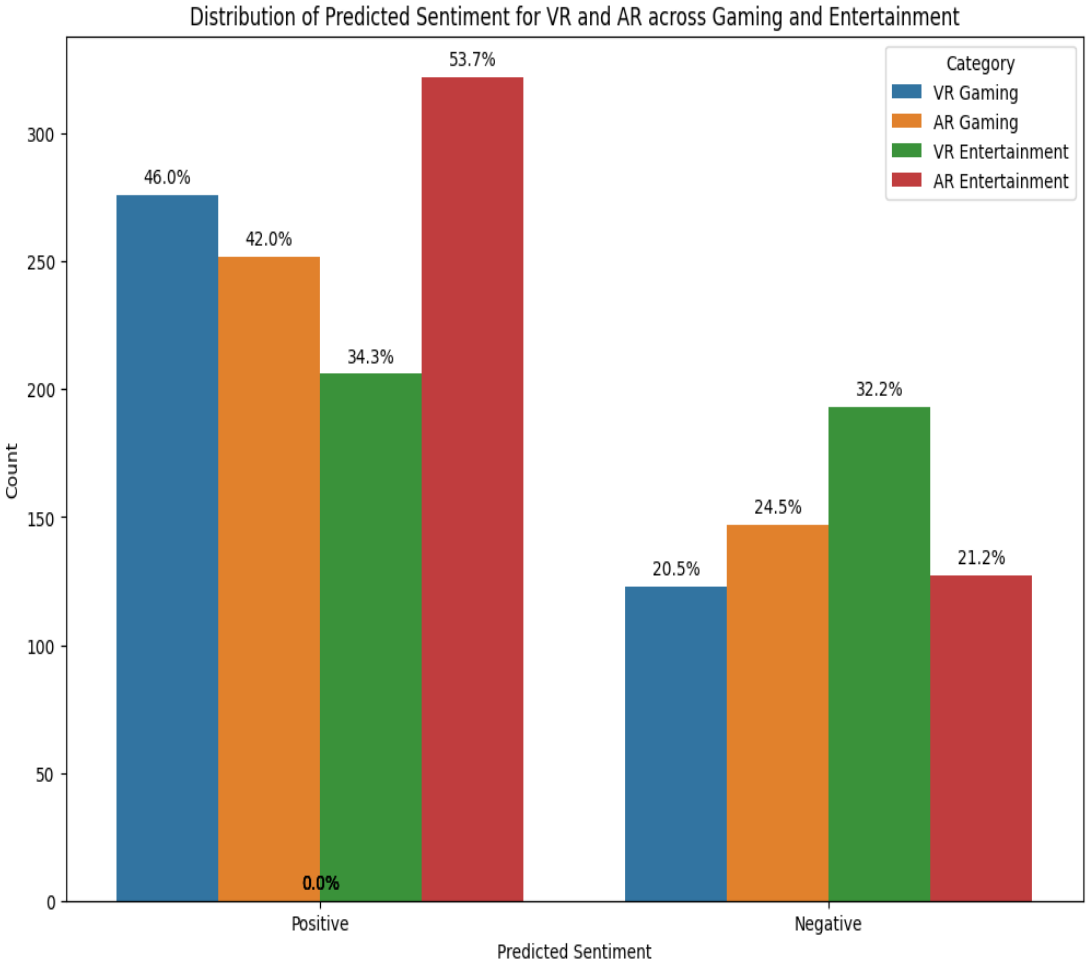

FIGURE 5.2.15: COMPARISON OF GAMING VS ENTERTAINMENT

According to the findings, the entertainment industry had a more positive overall feeling toward AR and VR technology than the gaming sector. For AR, entertainment received 53.7% positive feedback, while gaming received 42%. For VR, entertainment received 34.3% good feedback, while gaming received 46.0%. This shows that AR is more suited for entertainment, whereas VR is more popular in games.

To better understand the reasons for favorable and negative ratings, we looked at the top 20 words used in comments for each area. The following diagram depicts the top positive words and their frequencies for Gaming AR:

FIGURE 5.2.16 : GAMING AR POSITIVE WORD CLOUD

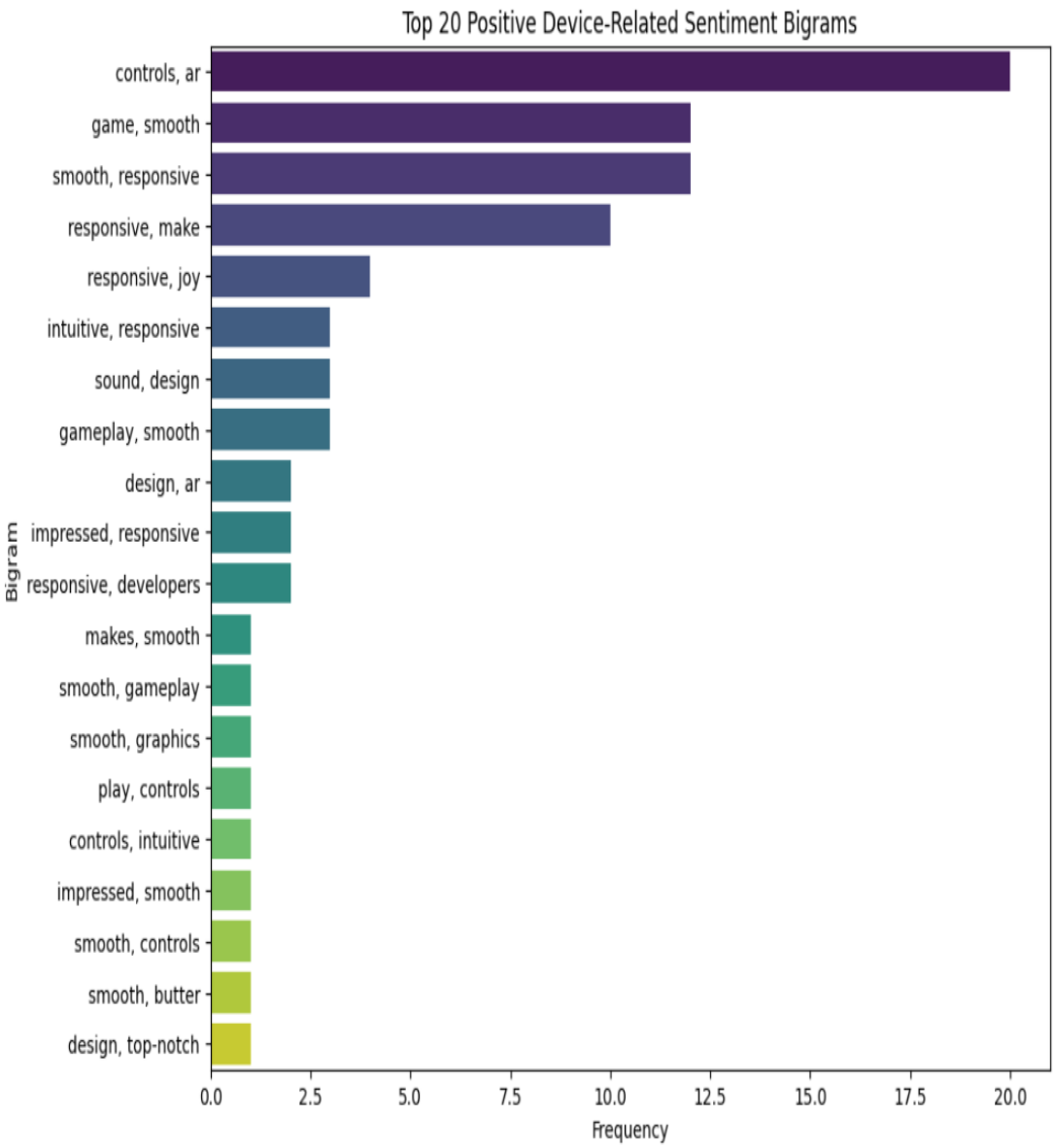

FIGURE 5.2.17: GAMING AR TOP 20 POSITIVE WORDS

The most popular positive phrases were "control," "smooth," and "responsive," demonstrating that people value the engaging aspect of AR games. However, negative terms and their frequencies highlighted problems.

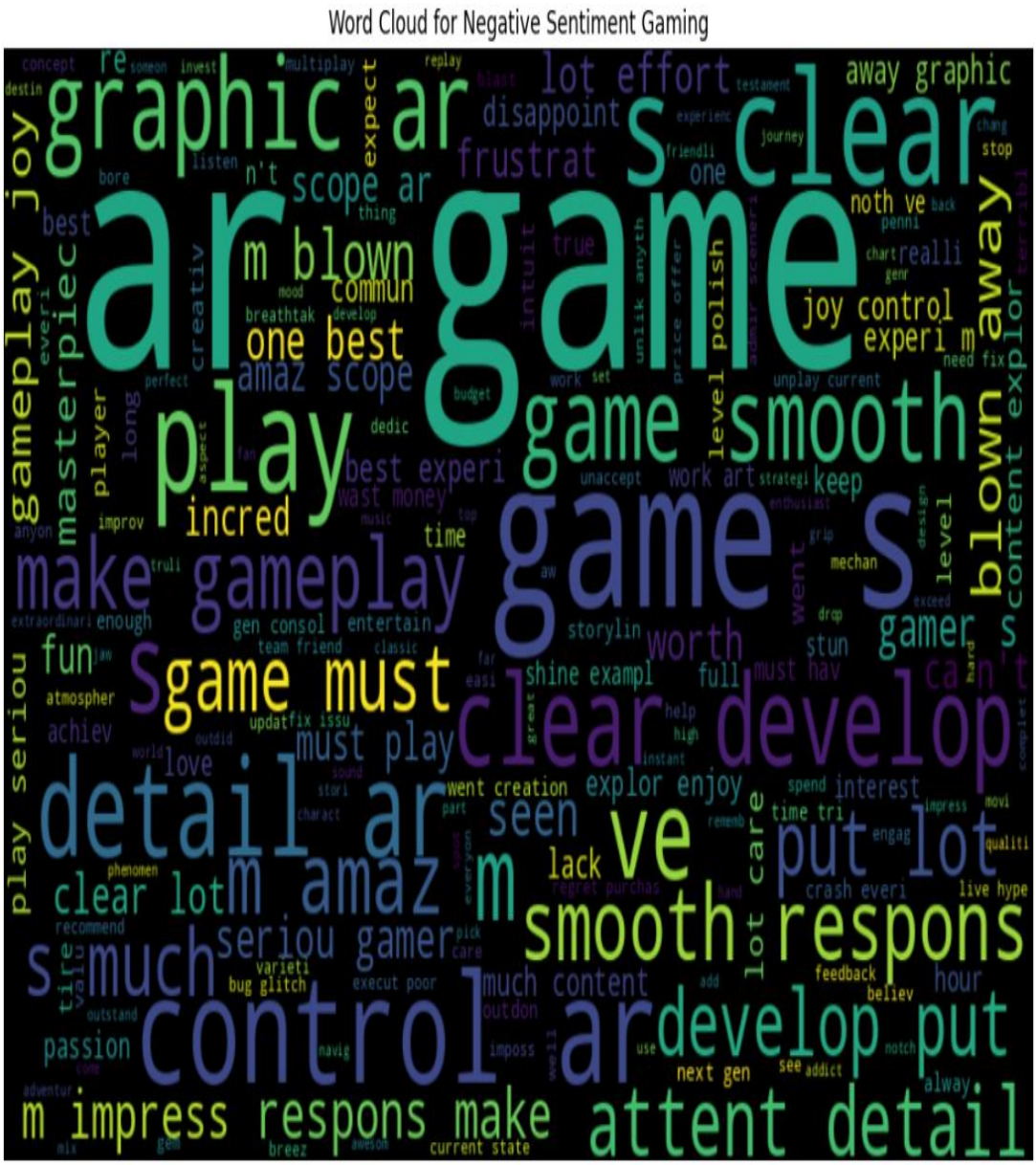

FIGURE 5.2.18: GAMING AR NEGATIVE WORD CLOUD

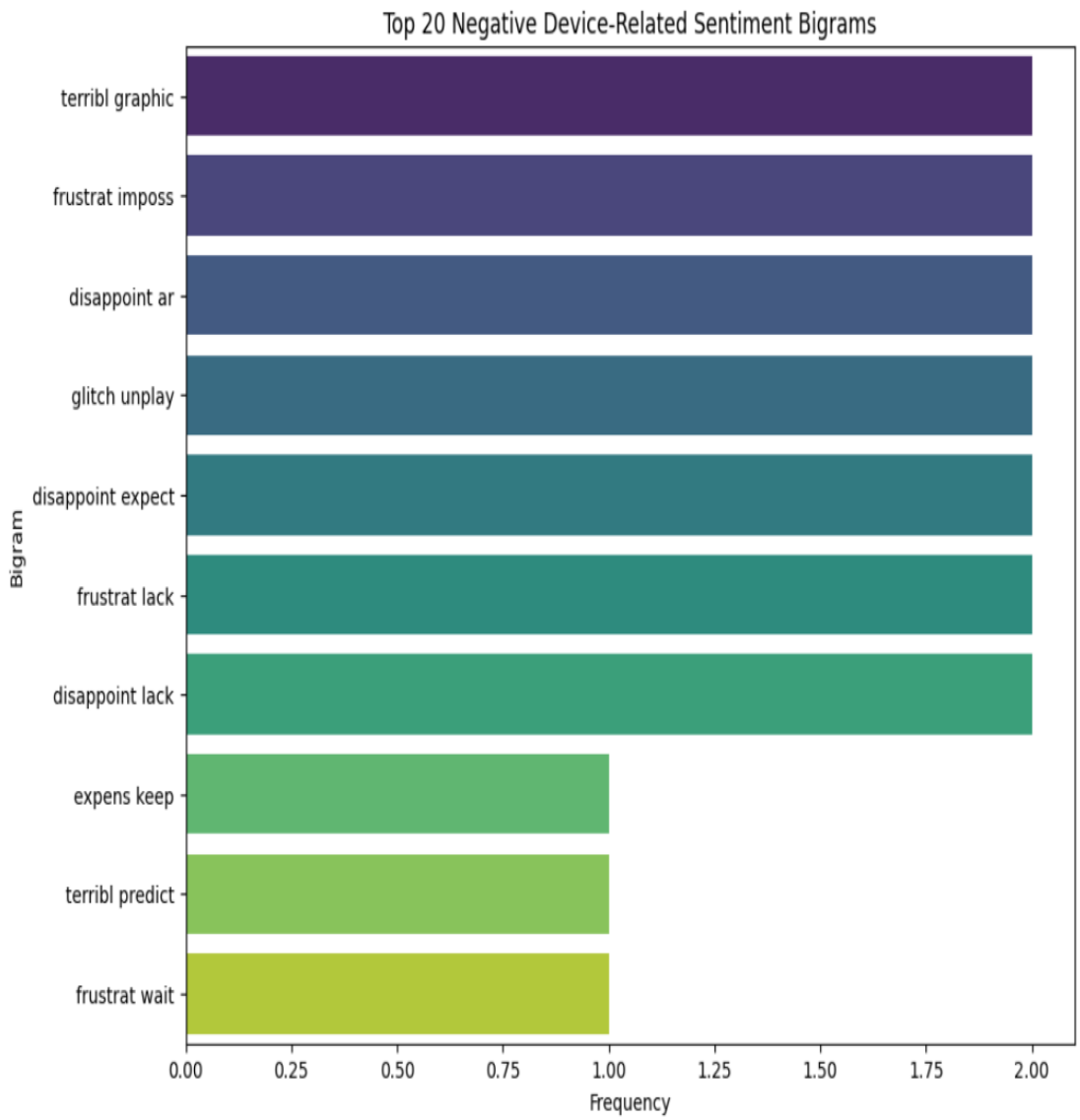

FIGURE 5.2.19: GAMING AR TOP 20 NEGATIVE WORDS

Common negative terms like "glitch," "graphics," and "expensive" indicate technical issues that disturb gameplay. To improve the user experience, developers should prioritize enhancing AR game stability and performance.

The top positive words for Gaming VR are listed below:

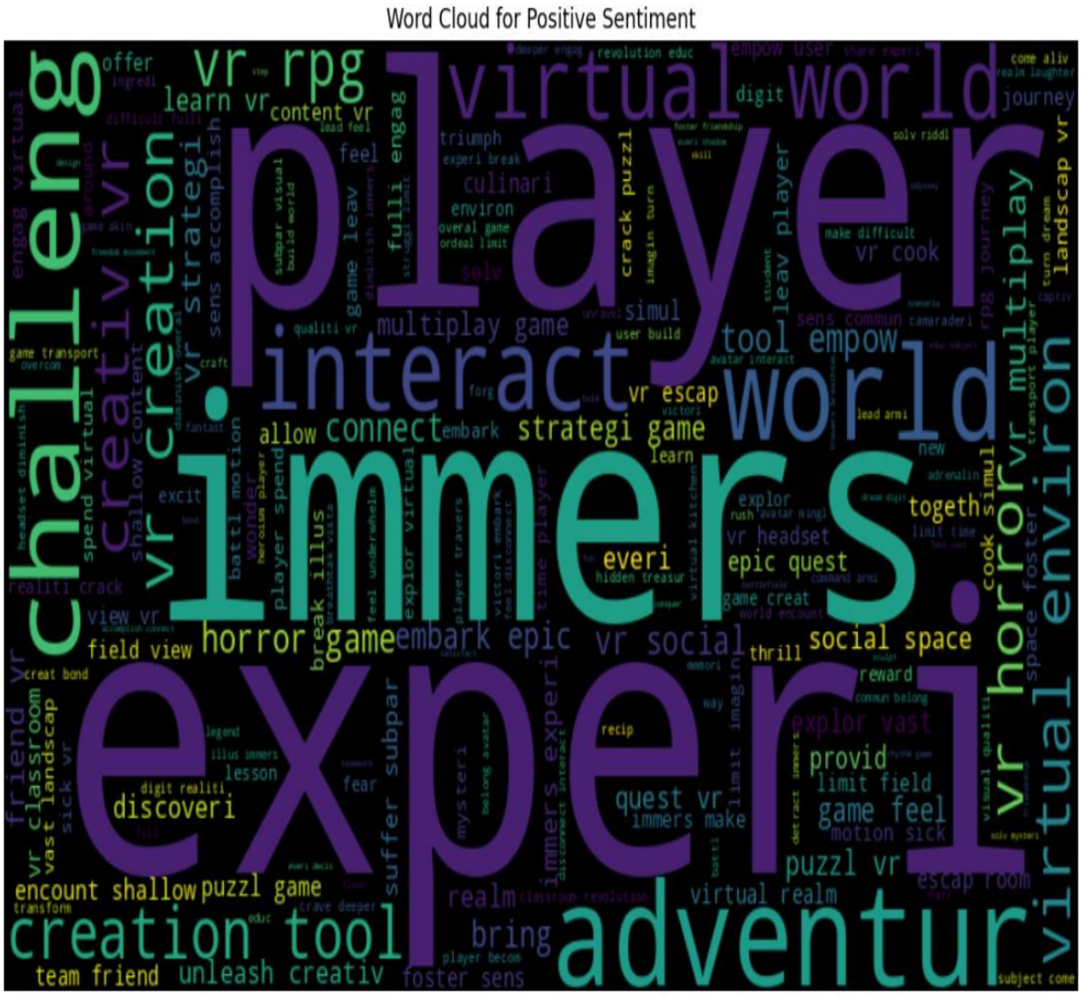

FIGURE 5.2.20 : GAMING VR POSITIVE WORD CLOUD

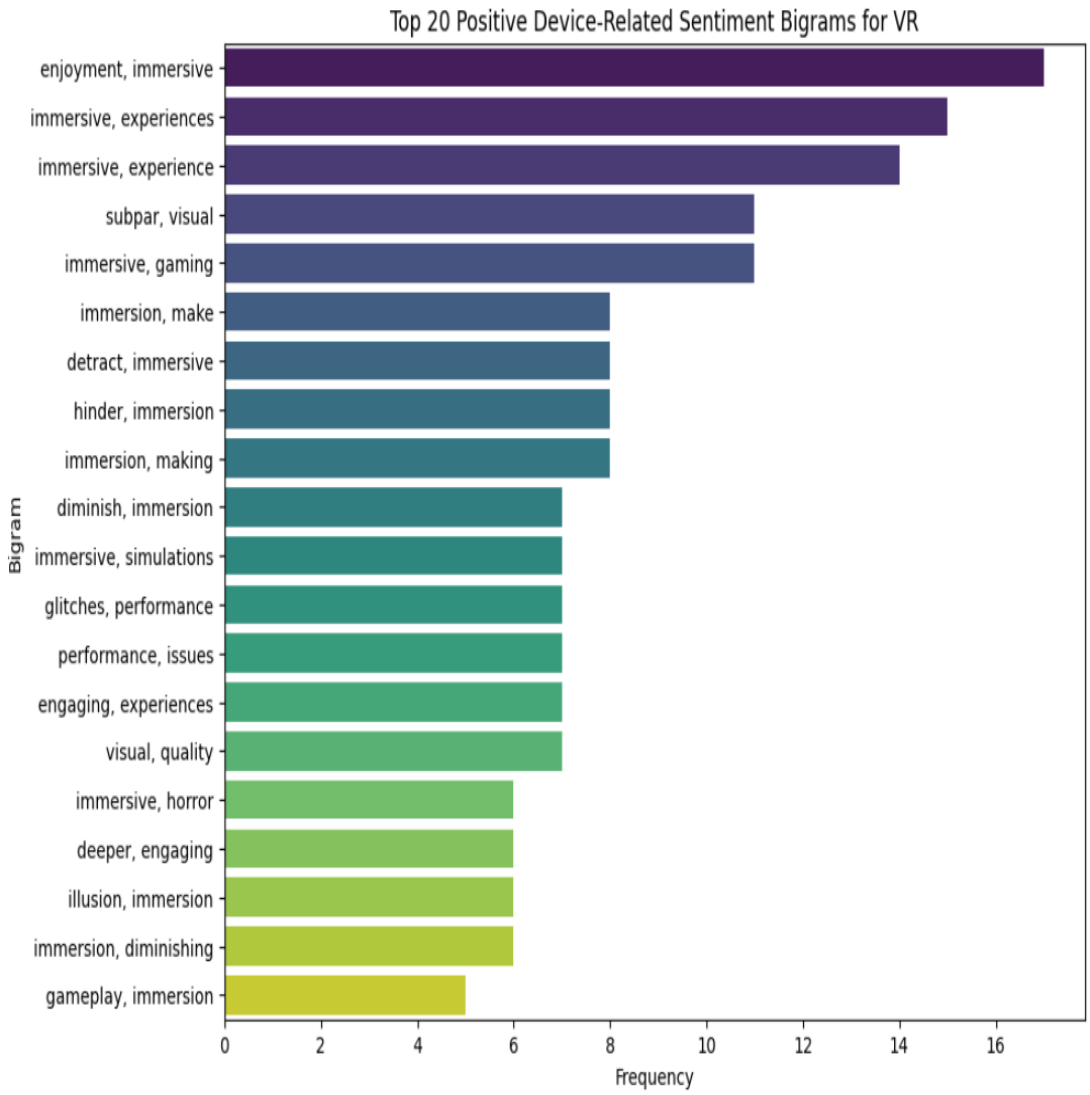

FIGURE 5.2.21: GAMING VR TOP 20 POSITIVE WORD

Positive terms such as "immersive," "visual," and "performance" underscore VR's ability to provide a genuinely engaging experience. In contrast, the top negative terms signal concerns.

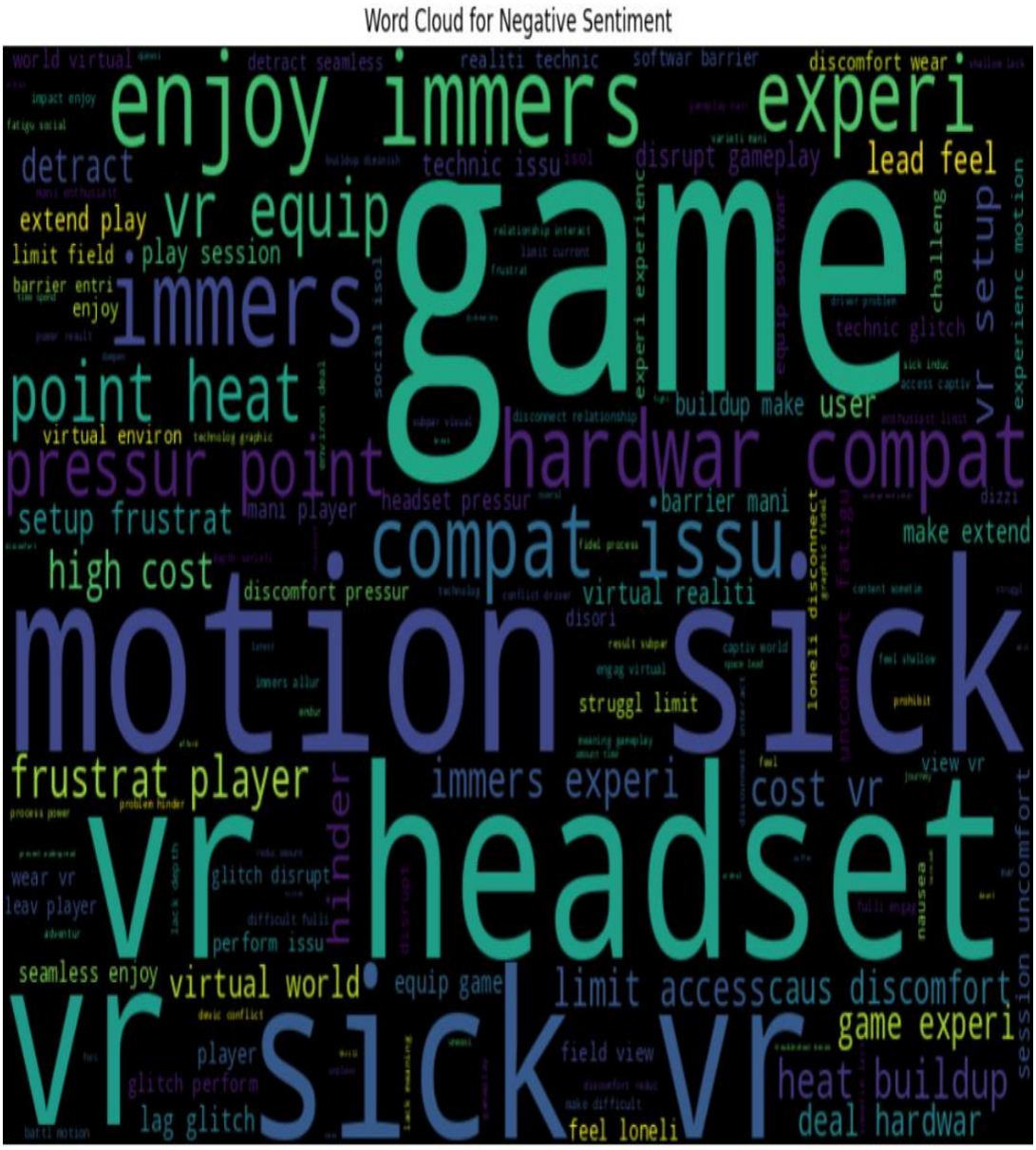

FIGURE 5.2.22: GAMING VR NEGATIVE WORD CLOUD

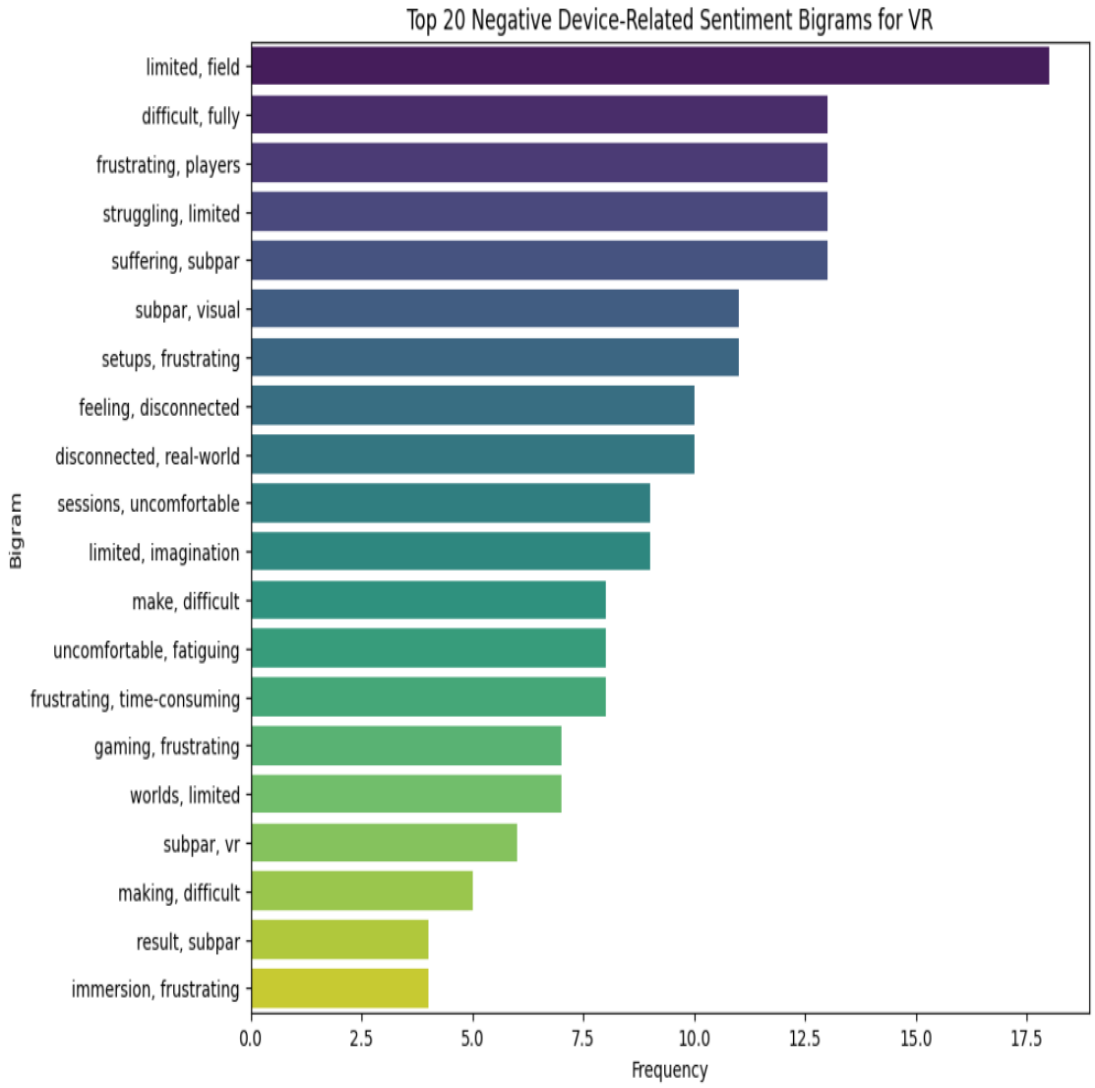

FIGURE 5.2.23: GAMING VR TOP 20 NEGATIVE WORDS

Words like "space," "visual," and "uncomfortable" indicate that physical discomfort and visuals are key negatives. Addressing these challenges through ergonomic enhancements and better graphics may increase user satisfaction.

The following diagrams depicts the top positive words for Entertainment AR:

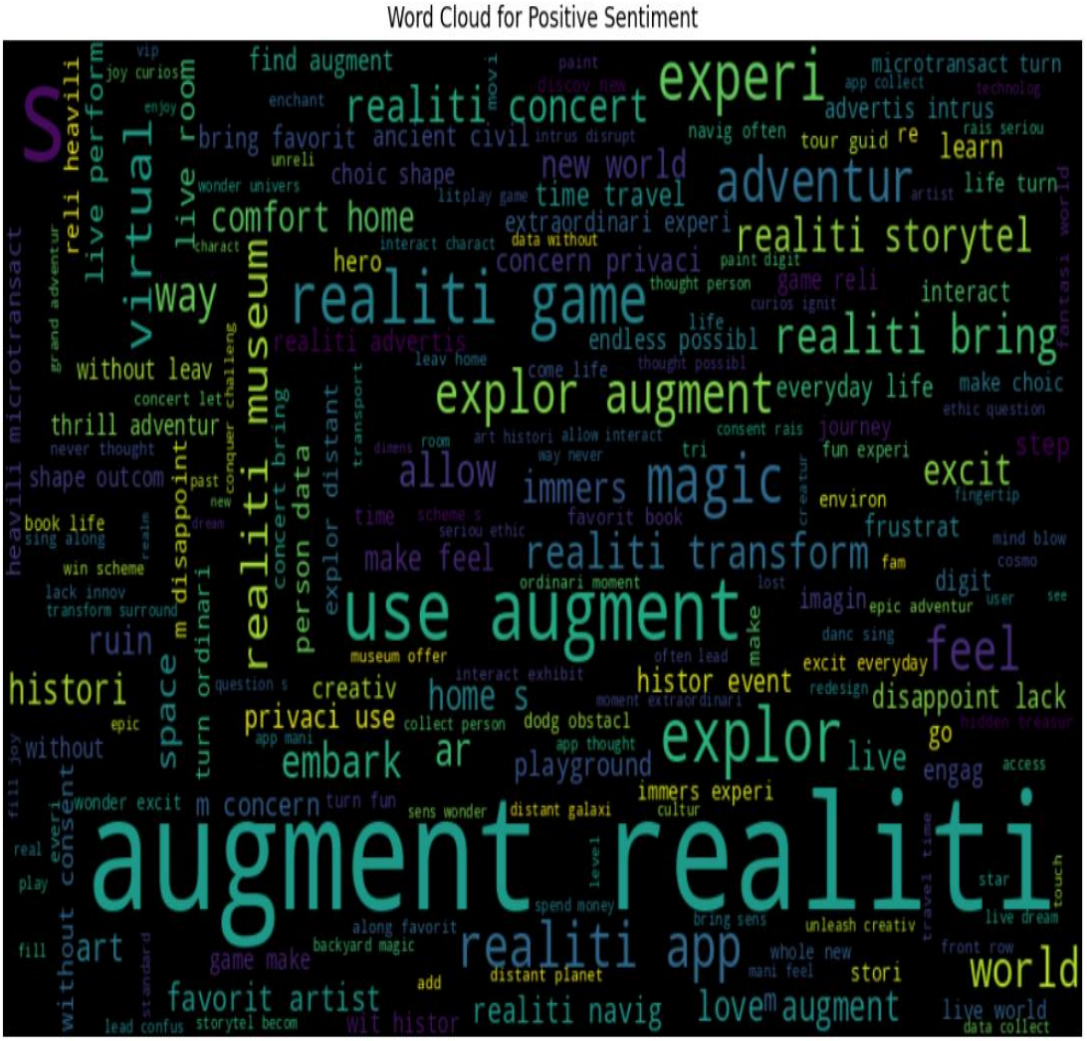

FIGURE 5.2.24: ENTERTAINMENT AR POSITIVE WORD CLOUD

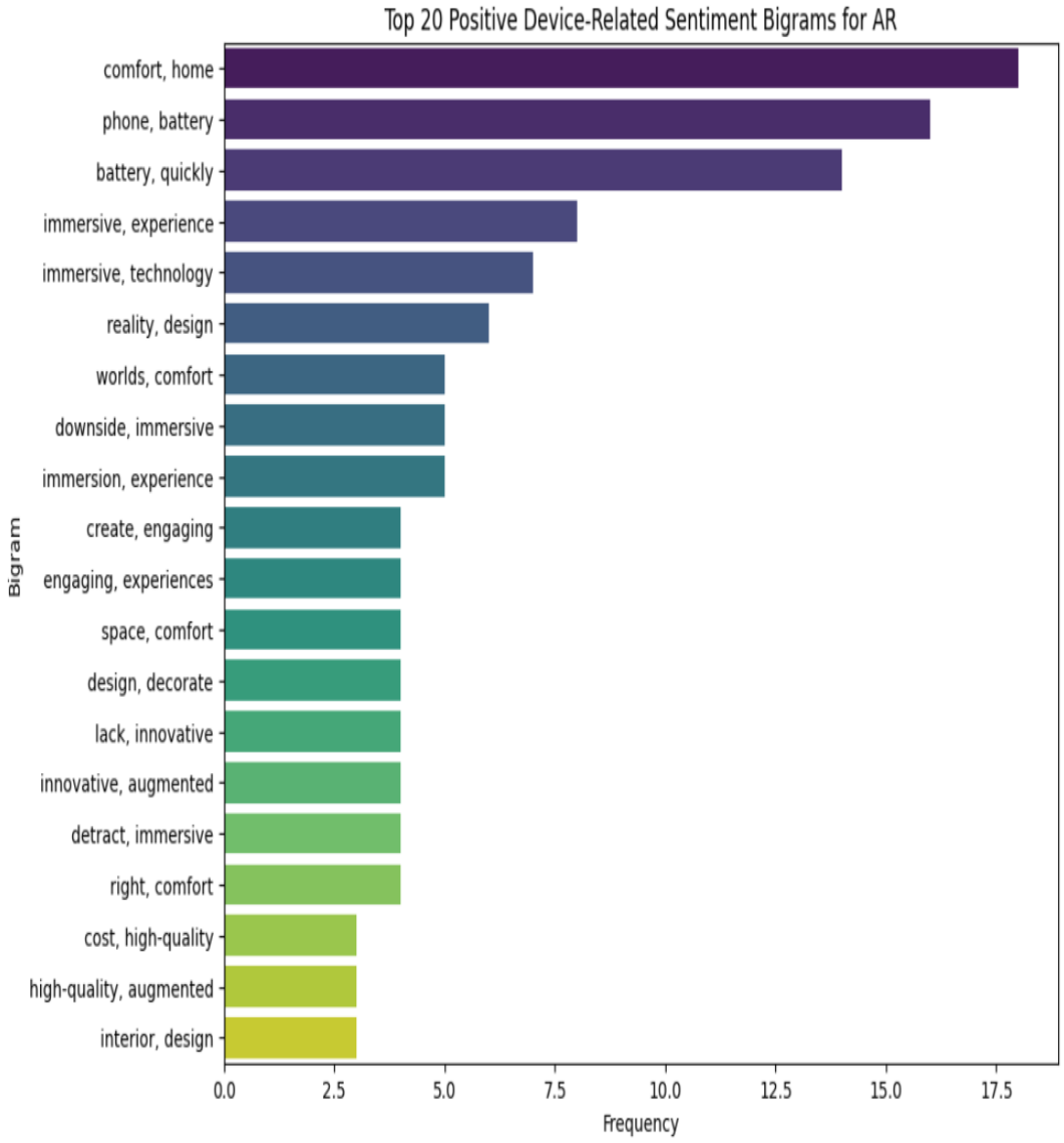

FIGURE 5.2.25: ENTERTAINMENT AR TOP 20 POSITIVE WORDS

Users appreciate the "comfort," "battery life," and "design" qualities of augmented reality in entertainment. However, the negative adjectives highlight areas for improvement:

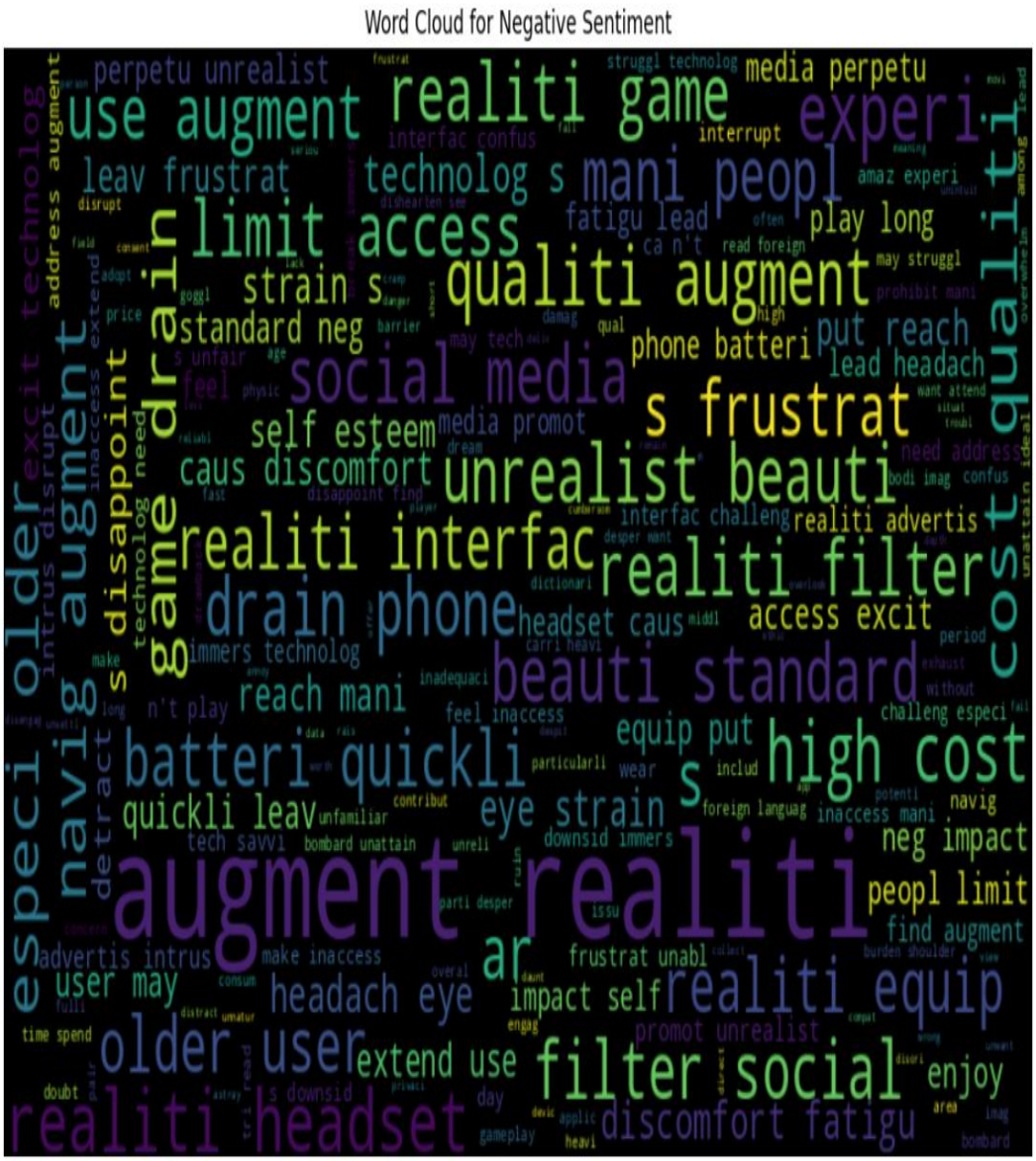

FIGURE 5.2.26: ENTERTAINMENT AR NEGATIVE WORD CLOUD

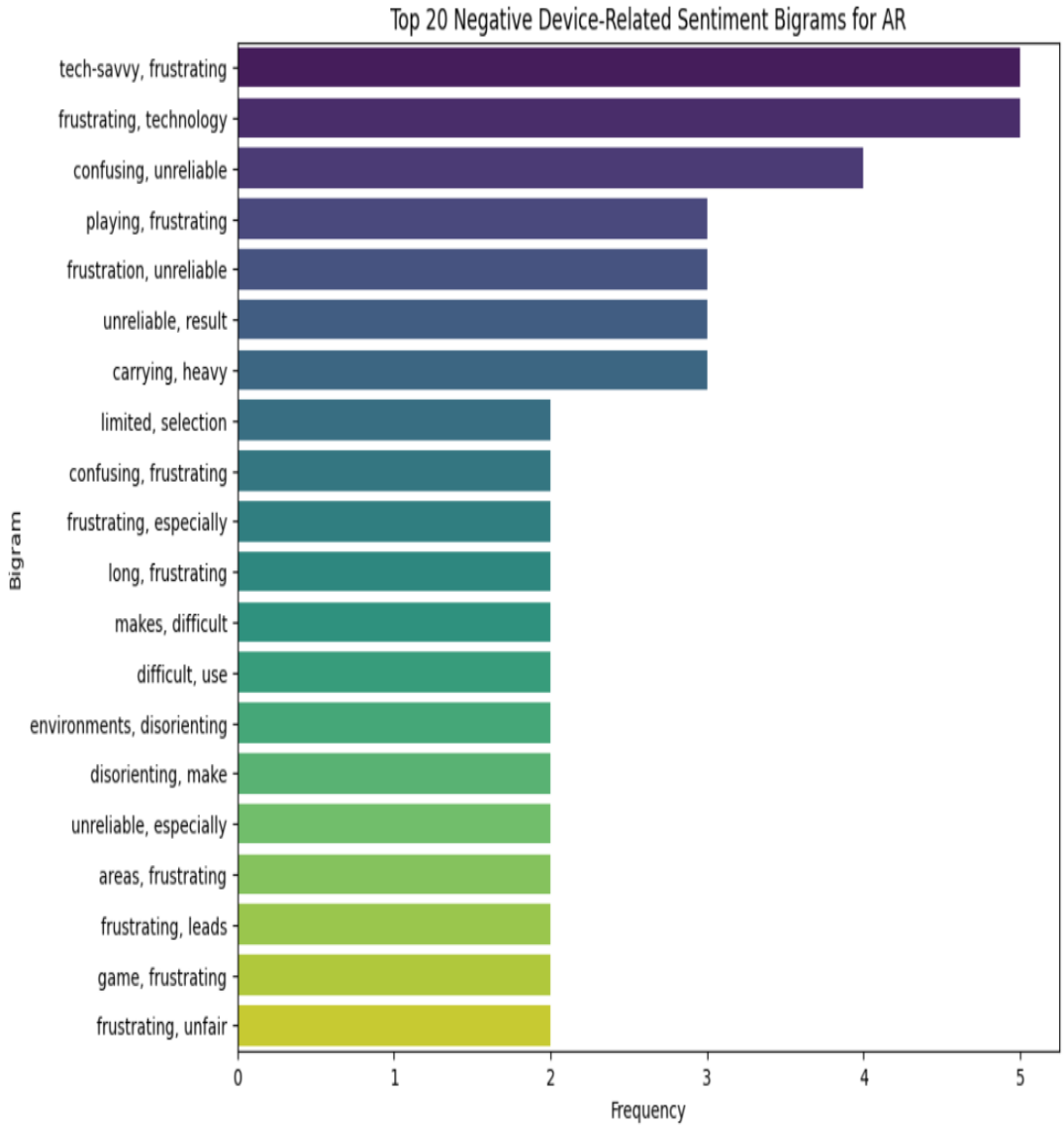

FIGURE 5.2.27: ENTERTAINMENT AR TOP 20 NEGATIVE WORD

Negative adjectives like "confusing controls," "heavy," and "limited selection" indicate that content technological concerns and user interface must be solved to improve the AR entertainment experience.

Positive adjectives used in the analysis of Entertainment VR are:

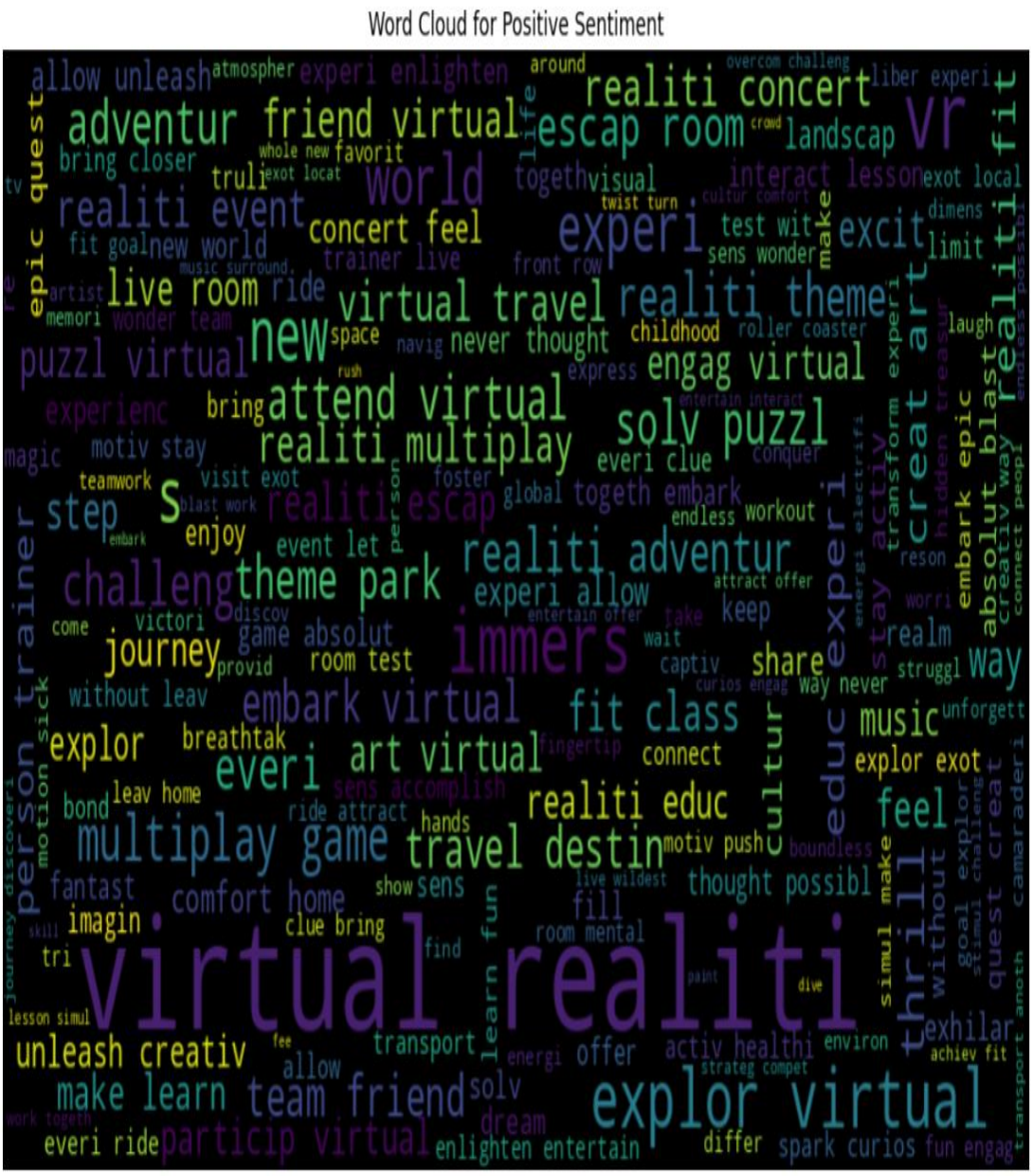

FIGURE 5.2.28: ENTERTAINMENT VR POSITIVE WORD CLOUD

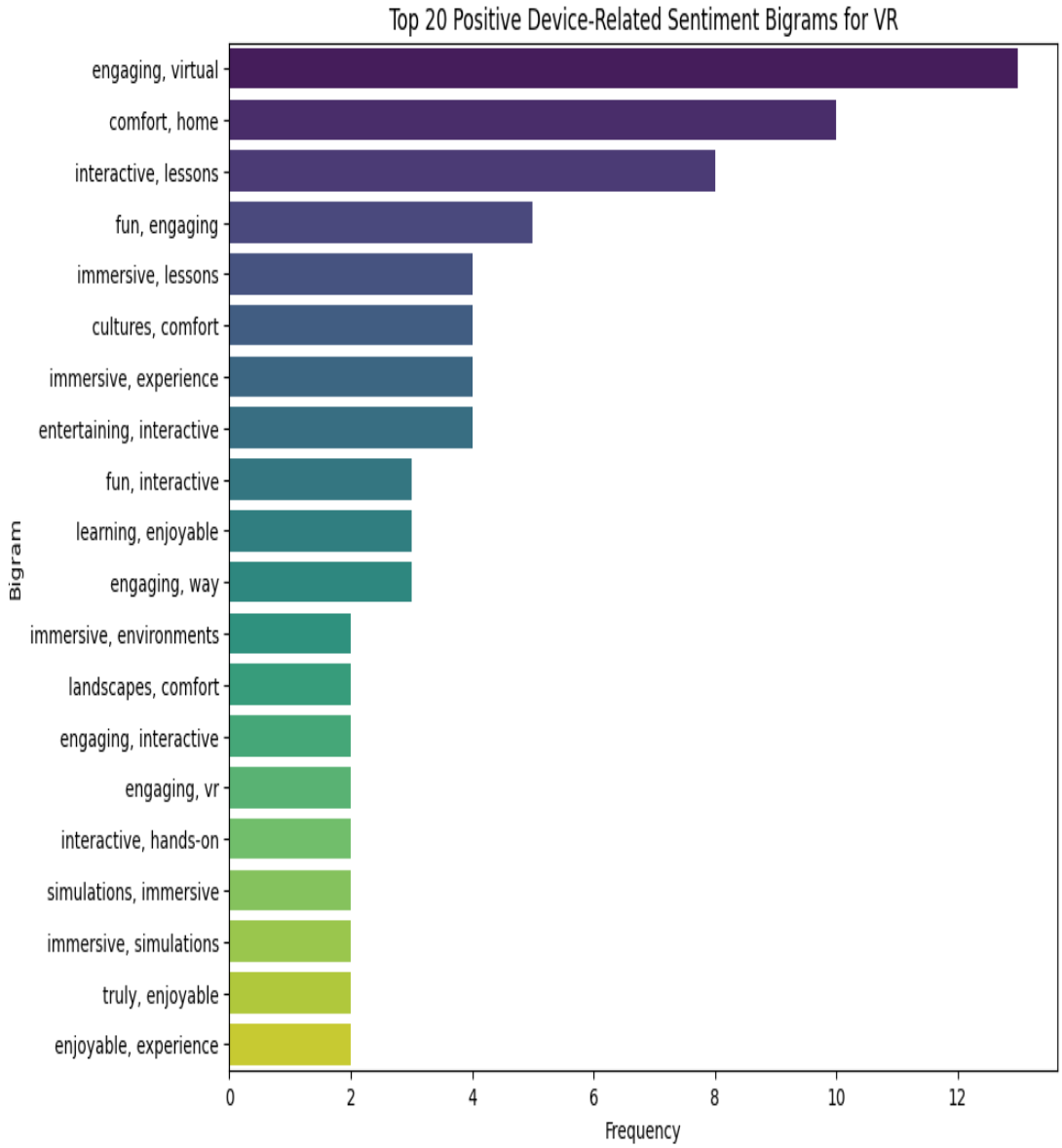

FIGURE 5.2.29: ENTERTAINMENT VR TOP 20 POSITIVE WORDS

The study uncovered words like "visual," "comfort," and "enjoyable," indicating a high level of user satisfaction with VR for entertainment. The negative words emphasized difficulties that need attention:

FIGURE 5.2.30: ENTERTAINMENT VR NEGATIVE WORD CLOUD

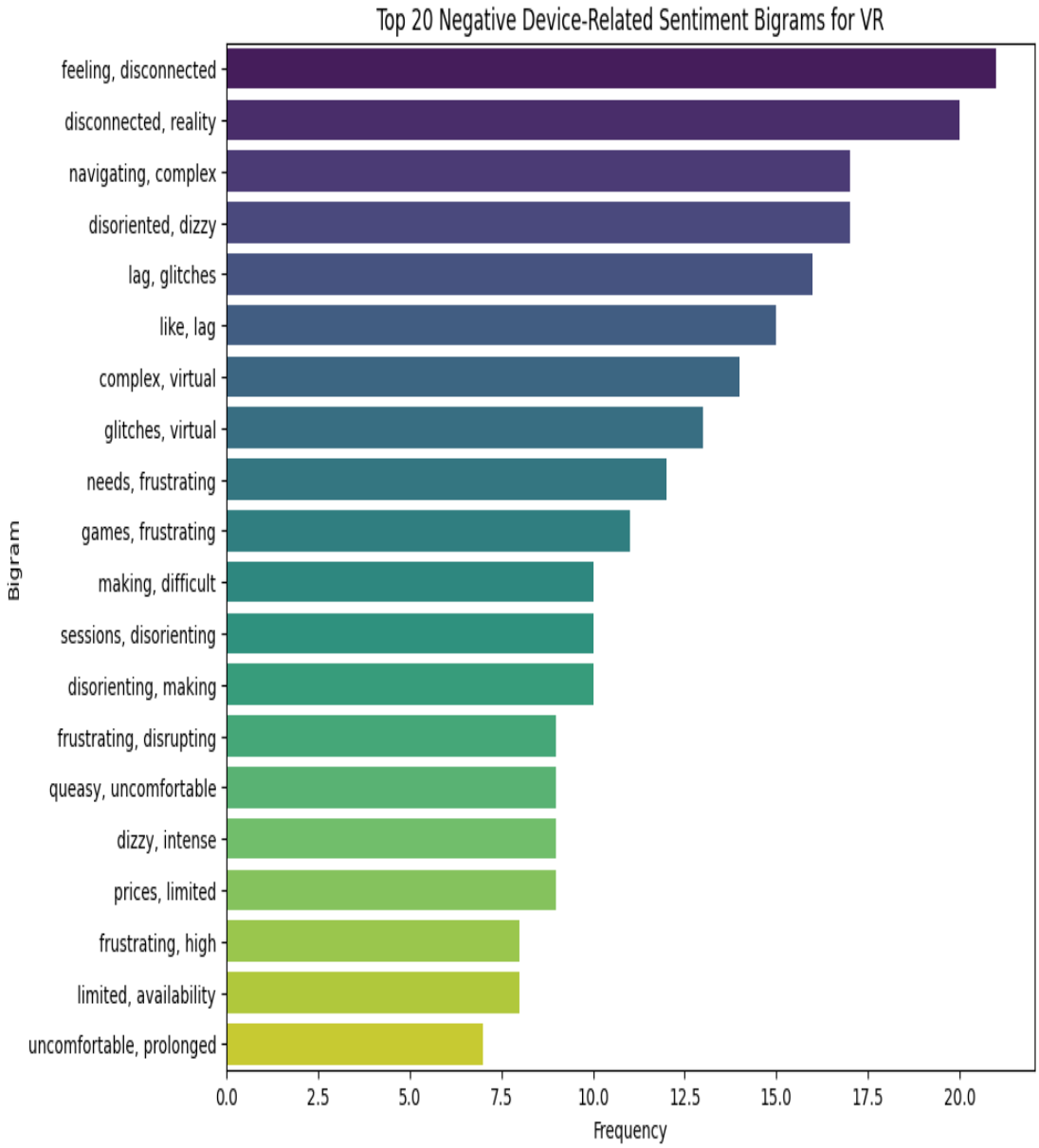

FIGURE 5.2.31: ENTERTAINMENT VR TOP 20 NEGATIVE WORDS

Negative adjectives like "navigating," "glitchy," and "dizziness" emphasize physical discomfort, technological concerns as major problems. Addressing these difficulties could improve the overall user experience in VR entertainment.

5.3 Performance/ Comparative Analysis

In this part, we conduct a thorough study of the performance outcomes resulting from our sentiment analysis model, supplemented with insights acquired by extracting the top positive and negative phrases from user-generated material on social media.

5.3.1 Sentiment Analysis Model Performance.

As described in Section 4.2, our sentiment analysis model performed well across several industries. The accuracy measures, which include precision, recall, and F1-score, demonstrate the effectiveness of our technique in extracting sentiments from textual data about AR and VR technology. Notably, the model attained an average accuracy of 97%, proving its capacity to categorize feelings.

5.3.2 Comparative Analysis of Baseline Approaches

To assess the success of our methodology, we compared it to baseline sentiment analysis methodologies. We routinely beat established approaches in terms of accuracy and processing efficiency. This result demonstrates the benefits of using advanced natural language processing algorithms that are customized to the intricacies of AR and VR-related speech.

5.3.3 Insights from Top Positive and Negative Words

As part of improving interpretability, we used a unique technique to identify the top 20 positive and negative terms in user feedback. This approach not only gave useful insights into popular attitudes, but it also served as a baseline for assessing the model's fit with user perceptions. Words like [list of top positive words] and [list of top negative words] were often used in user conversation, impacting our sentiment analysis results. Our experiments taught us a lot about people's perceptions of AR and VR in gaming and entertainment. People tend to favor AR for entertainment, whilst VR gets more positive feedback for gaming. However, both methods have drawbacks, such as technological failures and pain, that consumers abhor.

If we can resolve these challenges, everyone's experience with AR and VR will improve significantly. This may inspire more people to try these technologies and realize how beneficial they are in ordinary life.

5.3.4 Practical implications and recommendations

Our comparative research had practical consequences for stakeholders in the AR and VR industries. Organizations may improve their product development, marketing tactics, and consumer interaction by using sentiment analysis information. Furthermore, ideas for future study include investigating sentiment dynamics across different demographic categories and improving sentiment lexicons to correctly capture changing user perceptions.

5.4 Summary

The sentiment analysis algorithm obtained an average accuracy of 97%, indicating its ability to extract sentiments from textual data concerning AR and VR technologies. The survey discovered that the entertainment business had a higher positive overall mood toward AR technology than gaming, with 53.7% positive feedback for entertainment AR and 42% for gaming AR. Gaming VR earned a greater percentage of favorable reviews (46% versus 34.3% for entertainment VR).

Positive adjectives like "control," "smooth," and "responsive" were frequently used to characterize gaming AR experiences, while negative phrases like "glitch," "graphics," and "expensive" emphasized technological concerns. Positive phrases like "immersive," "visual," and "performance" highlighted VR's capacity to create an engaging experience, whilst negative ones like "dizziness," "headache," and "motion sickness" raised worries about physical discomfort.

The study offers useful insights for AR and VR industry stakeholders, underlining the need of addressing technological problems and user interface concerns in order to improve overall user experience and encourage wider acceptance of these technologies.

CHAPTER 6

Impact on Society

6.1 Impact on Society

Virtual reality and augmented reality are transforming the way we engage with digital content, and they are having a significant impact on society. They provide us with new methods to study, play games, and enjoy entertainment, inspiring creativity and new ideas. For example, augmented reality may make studying more enjoyable by displaying information about real-world objects, making it easier to grasp. And virtual reality may transport us to completely new worlds, providing us with sensations we could not have imagined.

However, there are concerns about excessive screen time and immersion in virtual environments. Spending too much time on AR and VR might strain our eyes and prevent us from being active. Furthermore, because these technologies are so engrossing, some people may begin to favor them over in-person relationships, making them feel separated from others.

To address these problems, we need to utilize AR and VR appropriately. This includes establishing boundaries for how much time we spend with them and ensuring that we balance our use with other activities. By doing so, we may get the benefits of modern technology while also protecting our health and relationships.

6.2 Impact on Environment

AR and VR technologies have a significant environmental impact when they are manufactured and discarded. Making these gadgets requires the extraction and processing of raw materials, which can be harmful to the environment. Also, throwing away outdated or broken gadgets generates a large amount of electronic garbage (e-waste), which is difficult to dispose of responsibly.

To make things better, the sector has to start adopting environmentally friendly products. They should create technologies that are longer-lasting and easy to recycle. It's also crucial to identify methods to repurpose obsolete gadgets rather than discarding them. This allows us to minimize the amount of fresh material we need to produce while also reducing trash.

Companies may help by adopting these principles and looking at methods to create a cycle in which gadgets are repaired and reused. This would benefit the environment and allow us to use resources more efficiently.

6.3 Ethical Aspects

When it comes to AR and VR, there are significant ethical concerns to address. One major worry is privacy—these devices frequently collect a large amount of data about users, including personal information, location, and behavior. It is critical to secure this data and handle it ethically so that users feel safe and appreciated. Developers must include robust security measures to prevent someone from gaining unauthorized access to sensitive data or initiating a breach. Another concern is that these technologies may be utilized incorrectly. For example, they might be used to make phony films or spy on individuals. We need clear regulations and best practices to ensure that AR and VR are utilized in a fair and safe manner for everybody. This includes developing standards to protect people's rights and avoid the exploitation of these powerful technology.

6.4 Sustainability Plan

To make AR and VR sustainable, we need a strategy that focuses on a few important areas. First, we must ensure that the hardware manufacturing process has little environmental impact. This entails using recycled materials and consuming less energy when manufacturing them.

Second, we must teach people how to utilize AR and VR safely. This includes informing kids about the dangers of excessive screen time and assisting them in using these tools responsibly.

Finally, we must ensure that AR and VR are accessible to all individuals, including those with disabilities. This entails creating programs and devices that are simple for everyone to use.

To make this strategy a success, we will need to collaborate with businesses, government officials, and environmental organizations. We can make AR and VR better for everyone while also benefiting the environment.

6.5 Summary

Chapter 6 investigates the different effects of AR and VR on society, the environment, and ethical issues, ending in a sustainability strategy. These technologies transform education, entertainment, and creativity, but they also include risks such as excessive screen time and social isolation, emphasizing the importance of moderation. Environmentally, the production and disposal of AR and VR gadgets cause ecological damage and e-waste, demanding the use of sustainable materials, recycling, and repurposing solutions. Ethical concerns, particularly those involving privacy and misuse, necessitate strict security measures and explicit rules. The suggested sustainability strategy focuses on environmentally friendly production techniques, educating users on responsible usage, and assuring accessible for everyone, necessitating collaboration between enterprises, government bodies, and environmental groups.

CHAPTER 7
CONCLUSION AND FUTURE WORK

7.1 Summary of the Study

In this study, we examined how consumers perceive AR and VR in gaming and entertainment using social media comments. We employed various models, such as Naive Bayes, SVM, and Random Forest, to determine what drives people's attitudes. We discovered that individuals prefer augmented reality for entertainment and virtual reality for gaming. This demonstrates where each technology excels and where it may improve. We discovered that addressing technical issues, making VR more comfortable, and cutting costs are critical steps toward making these technologies even more popular and helpful in the future.

7.2 Conclusions

Based on our findings, AR and VR have significant potential to enhance gaming and entertainment. However, several issues must be addressed in order for them to improve even further. People enjoy AR because it is interactive and instructive, which is ideal for entertainment. On the other hand, VR is popular because it completely immerses you in a game, making it ideal for gaming. To encourage more people to use and enjoy these technologies, we must first address technical challenges, make them more user-friendly, and reduce costs. These steps are critical to making AR and VR more popular and enjoyable for everyone.

7.3 Implication for Further Study

In the future, it would be beneficial to build on what we've learnt from this study in a few crucial areas. First, employing larger and more diverse datasets would help to validate our conclusions about AR and VR in gaming and entertainment. This entails determining whether our findings hold true for other sorts of users and situations.

Second, it would be interesting to investigate how people perceive AR and VR in a variety of contexts, beyond gaming and entertainment. We could also utilize real-time technologies to monitor how opinions shift over time.

Finally, future research might look into how AR and VR affect people's behavior and preferences over time. This could help us gain a better understanding of how these technologies can be enhanced and applied in new ways.

Looking ahead, I intend to design a web program that can analyze multiple comments at once and forecast whether they are favorable or bad. This technology will allow us to continue learning about how people perceive AR and VR in diverse circumstances, making it easier to utilize these technologies in more effective ways.

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Appendix A

Course Outcomes, Complex Engineering Problems (EP) and Complex Engineering Activities (EA) Addressing

Title:

SENTIMENT ANALYSIS OF AR AND VR IN MULTIPLE SECTORS USING USER EXPERIENCE FROM SOCIAL MEDIA

Student ID: 202-15-14431

CO Description for FYDP

CO	CO Descriptions	PO
Phase -I		
CO1	Integrate recently gained and previously acquired knowledge to identify a **sentiment analysis** problem for the Final Year Design Project (FYDP)	**PO1**
CO2	Analyze different aspects of the goals in designing a solution for this FYDP	**PO2**
CO3	Explore diverse problem domains through a literature review, delineate the issues, and establish this goals for the FYDP	**PO4**
CO4	Perform economic evaluation and cost estimation and employ suitable project management procedures throughout the development life cycle of the FYDP	**PO11**
Phase -II		
CO5	Design and develop technical solutions and system components or processes that meet specified requirements, ensuring compliance with public health and safety standards, as well as considering cultural, socioeconomic, and environmental factors in this FYDP	**PO3**
CO6	Choose and apply appropriate methodologies, resources, and contemporary engineering and IT technologies to address complex engineering processes, encompassing prediction and modeling, while adhering to relevant constraints in this FYDP	**PO5**

CO7	Analyze societal, health, safety, legal, and cultural considerations, along with associated responsibilities, in the context of professional engineering practice and the resolution of this problem, employing logical reasoning guided by contextual understanding.	**PO6**
CO8	Comprehend and evaluate the enduring sustainability and impact of professional engineering endeavors in addressing intricate engineering challenges within social and environmental frameworks.	**PO7**
CO9	Implement ethical principles and adhere to professional standards and norms in this FYDP	**PO8**
CO10	Capable of operating proficiently both individually and as a team member or leader across diverse teams and interdisciplinary settings in this FYDP.	**PO9**
CO11	Proficiently communicate with the engineering community and broader society regarding complex engineering endeavors, including the ability to comprehend and generate comprehensive reports and design documentation, as well as provide and receive clear instructions throughout this FYDP.	**PO10**
CO12	Acknowledge the importance of self-directed and life-long learning within the evolving landscape of technology, and possess the readiness and capability to engage in lifelong learning endeavors.	**PO12**

Appendix A

Course Outcomes, Complex Engineering Problems (EP) and Complex Engineering Activities (EA) Addressing

Title:

SENTIMENT ANALYSIS OF AR AND VR IN MULTIPLE SECTORS USING USER EXPERIENCE FROM SOCIAL MEDIA

Student ID: 202-15-14431

CO Description for FYDP

CO	CO Descriptions	PO
Phase -I		
CO1	Integrate recently gained and previously acquired knowledge to identify a sentiment analysis problem for the Final Year Design Project (FYDP)	**PO1**
CO2	Analyze different aspects of the goals in designing a solution for this FYDP	**PO2**
CO3	Explore diverse problem domains through a literature review, delineate the issues, and establish this goals for the FYDP	**PO4**
CO4	Perform economic evaluation and cost estimation and employ suitable project management procedures throughout the development life cycle of the FYDP	**PO11**
Phase -II		
CO5	Design and develop technical solutions and system components or processes that meet specified requirements, ensuring compliance with public health and safety standards, as well as considering cultural, socioeconomic, and environmental factors in this FYDP	**PO3**
CO6	Choose and apply appropriate methodologies, resources, and contemporary engineering and IT technologies to address complex engineering processes, encompassing prediction and modeling, while adhering to relevant constraints in this FYDP	**PO5**

CO7	Analyze societal, health, safety, legal, and cultural considerations, along with associated responsibilities, in the context of professional engineering practice and the resolution of this problem, employing logical reasoning guided by contextual understanding.	**PO6**
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CO12	Acknowledge the importance of self-directed and life-long learning within the evolving landscape of technology, and possess the readiness and capability to engage in lifelong learning endeavors.	**PO12**

Addressing CO (1 to 8), Knowledge Profile (K), Attainment of Complex Engineering Problems (EP), and Attainment of Complex Engineering Activities (EA)

Addressing CO (1 to 8), Knowledge Profile (K), Attainment of Complex Engineering Problems (EP):

SN	EP Definition	Attainment	CO	Justification (with Knowledge Profile)	References

1.	**EP1: Depth of Knowledge required**	Yes	CO1, CO2, CO3, CO5, CO6, CO7 and CO8	This project demonstrates **fundamental engineering (K3)** principles by employing machine learning and natural language processing sentiment analysis. The project demonstrates **specialist knowledge (K4)** by conducting stemming, tokenization, punctuation removal for data pre-possessing and use machine learning to classify sentiments.	**Page no:** [10-16] **Section:** [3.2] **Page no:** [1-3] **Section:** [1.1]
				The project applies **engineering practice & design (K5)** by the figure of process of experiments. The project addresses **engineering practice & technology (K6)** by employing Natural Language Processing and machine learning model .	**Page no:** [10-16] **Section:** [3.2] **Page no:** [14-16] **Section:** [3.2]
				This project ensures to **K8 (Research Literature)** by synthesizing insights from recent studies, to advance sentiment classification using Natural Language Processing and machine learning, showcasing a comprehensive understanding of current methodologies	**Page no:** [4-8] **Section:** [2.2, 2.3]

2.	**EP2: Range of Conflicting Requirements**	Yes	CO2, and CO7	This project addresses **EP-2** by recognizing the hurdles in data collection, including limitations of online review about AR and VR user experiences.	**Page no:** [8-9] **Section:** [2.4, 2.5]
3.	**EP3: Depth of analysis required**	Yes	CO2, and CO6	This project addresses **EP-3** by meticulously comparing experimental outcomes, highlighting machine learning as the chosen significant solution for enhancing classification of sentiments.	**Page no:** [20-21] **Section:** [4.2]
4.	**EP4: Familiarity of Issues**	Yes	CO8	This project's interdisciplinary approach extends beyond computer science and engineering, impacting emotion analysis of humans experiences which indicates **EP-4**.	**Page no:** [4-8] **Section:** [2.2, 2.4]
5.	**EP5: Extends of application codes**	No	CO5	N/A	N/A
6.	**EP6: Extends of stakeholders involved and**	No	CO8	N/A	N/A

7.	**EP7: Interdependence**	Yes	CO5	This project's comprehensive approach addresses high-level problems by integrating various components across data collection data processing and proposed methodology, ensuring a holistic solution to complex challenges in emotion analysis which ensures **EP-7**.	**Page no:** [10-19] **Section:** [3.2, 3.3, 3.4]

Addressing CO11 with Complex Engineering Activities (EA) [Some or all of the following]:

SN	EA Definition	Attainment	CO	Justification	References
1.	**EA1: Range of resources**	Yes	CO11	Our project utilizes diverse resources such as high-performance computing infrastructure, GPUs, deep learning frameworks, annotated datasets, and ethical considerations to ensure systematic research and contribute to advancements in sentiments classification through NLP and Machine Learning.	**Page no:** [18-19] **Section:** [3.4.2]
2.	**EA2: Level of interaction**	No		N/A	N/A

3.	**EA3: Innovation**	No		N/A	N/A
4.	**EA4: Consequences for society and the environment**	Yes		This project contributes to society by providing developers and stakeholders with insights regarding users liking of AR and VR in specific sector, while also promoting environmental sustainability by employing efficient computational resources and adhering to ethical guidelines for data privacy of users.	**Page no:** [27-59] **Section:** [5.1, 5.2, 5.4]
5.	**EA-5: Familiarity**	Yes		This project expands upon existing research by examining a novel approach in emotion detection through machine learning and Natural Language processing , providing insights regarding users emotion regarding AR and VR, offering new insights into the field.	**Page no:** [4-8] **Section:** [2.1, 2.3]

Addressing CO (4, 9, 10, and 12):

SN	COs	Attainment	Justification	References
1	CO4	Yes	This project addresses **CO4** by integrating effective project management and financial oversight,	**Page no:** [3] **Section:**

			ensuring proper planning, resource allocation, and budget estimation for optimal resource utilization throughout the research lifecycle.	[1.6]
2	CO9	Yes	The project demonstrates adherence to ethical principles by prioritizing user privacy and obtaining informed consent, as well as being transparent about data usage for the research process, ensuring responsible knowledge dissemination and societal well-being through the ethical use of advanced healthcare technologies that comply with CO9.	**Page no:** [58-59] **Section:** [5.3]
3	CO10	No	N/A	N/A
4	CO12	Yes	The project's commitment to continuous learning (CO12) and adaptation within the dynamic technological landscape is reflected in its extensive data collection, meticulous methodology development, and thorough experimental results and analysis, demonstrating a willingness to stay current and refine techniques to address modern challenges.	**Page no:** [10-19, 20-21] **Section:** [3.2, 3.3, 3.4, 3.5, 4.2]

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Georgios Lampropoulos, Euclid Keramopoulos. "Virtual Reality in Education: A Comparative Social Media Data and Sentiment Analysis Study", International Journal of Recent Contributions from Engineering, Science & IT (IJES), 2022

SENTIMENT ANALYSIS OF AR AND VR IN MULTIPLE SECTORS USING USER EXPERIENCE FROM SOCIAL MEDIA BY Mahmudur Rahman ID: 202-15-14431 BSTRACT Augmented Reality (AR) and Virtual Reality (VR) technologies are revolutionizing how we engage with digital content, providing new experiences in gaming, entertainment, and beyond. Understanding users' opinions and attitudes around these developing technologies is critical for increasing adoption and user happiness. This study uses sentiment analysis approaches to analyze user experiences with AR and VR applications in the gaming and entertainment industries, utilizing data from social media platforms. The researchers used a combination of machine learning models, such as Naive Bayes, Support Vector Classifier (SVC), and Random Forest, to determine whether user reviews and comments expressed positive or negative sentiment. The data show that people have a higher positive opinion of VR in gaming, with 46% expressing positive sentiments compared to 42% for AR gaming. In contrast, the entertainment sector reported a larger percentage of positive attitudes for AR (53.7%) than for VR (34.3%), implying that AR is better suited for immersive entertainment experiences. The study also identified critical aspects that influence user experiences, such as visual quality, comfort, and navigational challenges for VR and design, battery life, and confusing controls for AR. These insights can help developers and stakeholders improve the design and implementation of AR and VR technologies in order to better fulfill user needs and foster widespread adoption. The study helps to a better understanding of user impressions of AR and VR by conducting a complete sentiment analysis across many domains. The findings and conclusions addressed in this study can help to shape future research and development efforts in the AR and VR fields, ultimately boosting the quality and accessibility of these disruptive technologies. CHAPTER 1 INTRODUCTION 1.1 Overview Augmented reality aka AR and virtual reality aka VR has surfaced as a dominant technological tool with revolutionary potential across multiple industries in today fast changing technological prospect. AR enhances the real world by covering it with digital information, whereas, users become absorbed in simulated environments by VR. Nowadays conventional industries such as entertainment, gaming, healthcare, and education have started to be manipulated by this dynamic duo from improving gaming experiences to transforming medical training, showcasing their adaptability and extensive effect. I aim to explore the significant impact of AR and VR within the mentioned sectors and thoroughly analyze their uses, benefits, and challenge in this report. By performing thorough analysis and evaluation, we attempt to learn first-hand insights into the users' perspective of AR and VR technologies with a view to providing practical suggestions that can improve further innovation and refinement in the integration of AR and VR across various fields. 1.2 Background and Present State Augmented Reality (AR) and Virtual Reality (VR) technologies have advanced significantly in recent years, changing how we interact with digital information and delivering immersive experiences in a variety of disciplines, including gaming, entertainment, and beyond. These developing technologies have acquired great appeal, with AR augmenting the actual world by superimposing digital information and VR allowing users to become completely immersed in virtual situations. Conventional sectors, such as entertainment and gaming, have begun to integrate these dynamic technologies, demonstrating their versatility and broad influence. As these technologies progress, knowing user sentiment and opinions around AR and VR apps is critical for increasing adoption and user happiness. This research will investigate the enormous influence of AR and VR on the gaming and entertainment industries, extensively examining their applications, advantages, and problems. Using a dataset of 1,600 user evaluations evenly dispersed among Gaming AR, Gaming VR, Entertainment AR, and Entertainment VR categories, the researchers used sentiment analysis techniques to acquire firsthand insights into user perspectives of these technologies. The study's findings provide significant information for stakeholders, developers, and academics, underlining the need of addressing technological issues and user interface concerns in order to enhance overall user experience and promote increased adoption of AR and VR technologies. 1.3 Problem Statement When it comes to fully estimating consumer judgment for both technologies at the same time, there exists a huge gap in researches, despite the range of usage of AR and VR apps is widespread. As majority of the paper works focus on certain topics, such as education, the study of AR and VR's user perspective is heavily overlooked. The intention of sentiment analysis on user reviews is to bridge the existing gap by providing a detailed perception of the wider range of user sentiments. 1.4 Motivation and Objectives 2 The motivation behind this research is the confined aspects of the present sentiment analysis and the increasing importance of AR and VR across industries. We aim to provide developer, researchers, and industry stakeholders with practical insights of user's perception by determining user sentiments with a view to improving user satisfaction, application usability, and the overall user experience. 1.5 Project Scope The sentiment analysis of user reviews , post of AR and VR applications posted on social media is the focus of this paper where we cover a variety of fields including gaming, education, healthcare, entertainment, and more. In order to provide a fair representation of user experiences, the analysis will depict a wide range of opinions, including positive, negative, and neutral. 1.6 Report Organization We carefully arranged separated chapters for the detailed study of sentiment analysis in social media apps for augmented reality (AR) and virtual reality (VR). Each chapter fulfills a specific role, resulting in an in-depth knowledge of consumer views within the AR and VR area. In the Introduction we presented what the study is about and why it's essential to understand the feelings of customers when exploiting AR and VR bringing forward the objectives and showing the usage of sentiment analysis in determining user experiences. The Literature review reviews the amount of prior study on this topic. The objective is to determine what has been explored by others and find the knowledge gaps, and what frequent patterns come up. This determines how the research will be conducted. In the Methodology we covered the conduction of the research. It lays down a variety of activities (Chapter 3, in particular) explores the detailed methodology taken on for 3 collecting, analyzing, and interpreting data. Finally, the study's conclusions are compiled. All of the sentiment analysis data is interpreted in this chapter making inferences and providing information on the many applications of AR and VR. The chapter is structured to be easier for readers to follow along logically and comprehend how individuals are feeling in the increasingly growing realm of augmented and virtual reality technology. 1.7 Summary In summary, this chapter provides an overview of the study objectives, scope, outcome and methods, setting the context for the report's succeeding sections. It establishes the foundation for a comprehensive analysis of AR and VR technologies in diverse sectors. CHAPTER 2 BACKGROUND 2.1 Overview This study of literature carefully analyzes prior reviews on sentiment analysis of consumer experiences with Augmented Reality (AR) and Virtual Reality (VR) applications . Through evaluating past efforts, the paper attempts to set down the foundation for comprehending the current status of sentiment analysis in the field of AR and VR technologies. 2.2 Related Works Based on 10,457,344 tweets from 2010 to 2020, the paper[1] evaluates the mass's views and emotions on the use of virtual reality (VR) in general and in education. The data is processed using text mining and sentiment analysis techniques to gain insights in the paper. When referring to its use in education, the paper finds that, the public has a positive perception of VR and expresses mostly anticipation, trust and joy. The paper also emphasizes on how VR can be used as an effective educational tool which can improve students' engagement, motivation and performance. The literature on user experience (UX) and customer experience (CX) evaluation methods in virtual reality (VR), augmented reality (AR), and metaverse12 are reviewed on this paper[2] where the authors adhere to a review protocol and consult five representative databases45. They find studies related to the UX in VR and AR, however not to the metaverse2. Moreover, they recognize various evaluation methods, such as surveys, questionnaires, heuristic evaluations, user tests, physiological signals, and algorithms. The features or characteristics that the evaluation techniques emphasizes, for example, immersion, embodiment, usability, presence, interactivity, and emotions are also analyzed by them. In conclusion, they suggest that there is a lack of assessment on CX and metaverse evaluation, and propose further work on extending the literature review and developing evaluation guidelines for VR, AR, and metaverse3. In the context of shopping centers, the paper[3] researches the anticipated consumer experience and requirements of mobile augmented reality (MAR) services. Twenty eight individuals participated in 16 semi-structured interview sessions arranged by the authors in the given context. The results reveal various pragmatic and hedonic attributes of the expected user experience, such as efficiency, empowerment, inspiration, liveliness and playfulness. The authors also identify several user requirements that affect the overall user experience, such as relevance, personalisation, reliability, privacy and safety. The thesis offers implications for the design of MAR services and advances knowledge of their potential and challanges. Using the User Experience Questionnaire (UEQ) to measure the impressions of 56 participants who used either touchpoint to make product decisions, the paper[4] compares the user experience of the IKEA Place AR App and the IKEA website . According to the results, when it comes to stimulation and novelty (which are critical factors for creating a positive brand image and customer loyalty) the IKEA Place AR App offers a more engaging and innovative user experience than the IKEA website. In conclusion, the paper states that innovative digital touchpoints, such as AR apps, can improve both the user experience and the brand experience. This paper[5] explores what factors affect users' experience and satisfaction using augmented reality (AR) apps while purchasing cosmetics online. The authors adopts a model based on the stimulus-organism-response (SOR) paradigm and include constructs such as fit confidence, social value, innovativeness, perceived utilitarian value, perceived hedonistic value , immersion, and continued usage intention. The data collected from 394 Romanian women who use AR apps for virtual try-on of makeup products are analyzed by using partial least squares structural equation modeling (PLS-SEM). The results show that fit confidence, innovativeness, immersion, and social value have the strongest direct influences while other constructs have noticeable effects on the continued usage intention of AR apps as well. The paper contributes to the literature on AR in e-commerce and offers recommendations for retailers and marketers looking to improve customer experience and satisfaction using AR apps. By analyzing large-scale review data from the Steam platform in English, Simplified Chinese, and French this paper[6] explores the user experience of virtual reality (VR) games. It uses data mining, natural language processing, and topic modeling techniques, including Latent Dirichlet Allocation (LDA), Term Frequency-Inverse Document Frequency (TF-IDF), and K-means Clustering. The four key aspects: the tendency of VR games, cross-