Research on Emotion Recognition-Based Smart Assistant System: Emotional Intelligence and Personalized Services

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Abstract. The aim of this thesis is to develop an intelligent assistant system equipped with emotion recognition function to enhance its emotional intelligence and personalized service. In the context of today's rapid development of information technology, intelligent assistant systems have become an indispensable part of people's daily life. However, existing intelligent assistant systems generally lack the ability to perceive users' emotions and personalities, which makes it difficult for them to accurately understand users' real needs in the service process. This paper discusses the development of an intelligent assistant system with emotional intelligence and personalized service capabilities. The system can accurately identify the user's emotional state and provide the user with more tailored services and recommendations based on the emotional state and historical behavioral data. In addition, through user behavior analysis, the intelligent assistant system can better understand user needs and improve user satisfaction, thus enhancing its usefulness and user experience in daily life and work. This study has important theoretical and practical significance. Theoretically, it enriches the research content in the fields of affective computing and personalized recommendation, and expands the application areas of intelligent assistant systems. In practice, the research results can provide useful references for the development and optimization of intelligent assistant systems and provide better intelligent services for users.

Keywords: Emotion Recognition, Intelligent Assistant Systems, Personalized Services, Multimodal Data, User Behavior Analysis, User Experience, Emotional Intelligence, Artificial Intelligence

1. Introduction

With the continuous development and popularization of artificial intelligence technology, intelligent assistant systems have become an integral part of people's lives. These intelligent assistant systems can help users with daily tasks, answer questions, provide personalized suggestions and recommendations, and so on. However, most intelligent assistant systems currently lack emotional intelligence and personalized services to truly understand and satisfy users' emotional needs.

Emotion recognition, as one of the important branches in the field of artificial intelligence, is dedicated to recognizing and understanding human emotional states. Emotion plays an important role in interpersonal communication and decision-making process, so it is of great significance to introduce emotion recognition technology in intelligent assistant systems. By recognizing the user's emotional state, the intelligent assistant system can better adapt to the user's needs and provide more personalized and humanized services (Liu et al., 2018).

Emotion plays an important role in interpersonal communication and decision-making process, which influences people's attitudes, behaviors and decisions. Therefore, it is of great significance to introduce emotional intelligence in intelligent assistant systems. Through emotion recognition technology, intelligent assistant systems can more accurately understand and recognize the user's emotional state, so as to make more intelligent and attentive responses (Ko, 2018). For example, when a user expresses dissatisfaction or low mood, the intelligent assistant system can provide words of encouragement and comfort, thus enhancing user experience and satisfaction.

In addition, personalized service is also an important direction for the development of intelligent assistant systems. Each user's needs and interests are different, and traditional intelligent assistant systems are often unable to provide appropriate services and recommendations based on the user's personalized characteristics (Wang et al., 2018). However, through emotional intelligence and data mining technology, intelligent assistant systems can analyze the behavior and preferences of users, so as to provide personalized services and recommendations for users and increase user stickiness and loyalty.

Therefore, studying how to introduce emotional intelligence and personalized services in intelligent assistant systems has become one of the current research hotspots in the field of artificial intelligence. Many researchers and enterprises have invested in the exploration and practice of this field, hoping to develop a more intelligent and humanized intelligent assistant system to provide users with better usage experience and services (Liu et al., 2017).

However, there are some challenges to realize emotionally intelligent intelligent assistant systems. First, emotion recognition involves the processing of multimodal data, including speech, text, images, and video. How to recognize these different types of data for effective emotion recognition is a complex problem. Second, intelligent assistant systems need to be able to accurately recognize and understand the user's emotional state in order to react and respond accordingly (Liu et al., 2022). This involves the design and optimization of emotion recognition algorithms. Finally, intelligent assistant systems need to acquire and analyze users' emotional data while protecting their privacy, which is also a sensitive issue.

To address these challenges, this dissertation aims to investigate intelligent assistant systems based on emotion recognition, focusing on the need for personalized and emotion-aware services. Through in-depth analysis of users' emotional data and behaviors, this research aims to design and optimize emotion recognition algorithms to achieve accurate perception of users' emotional states and provide personalized services and recommendations to users accordingly (Fedotov, 2022).

The research and application of intelligent assistant systems is one of the hotspots in the field of artificial intelligence, attracting the attention and investment of many researchers and enterprises. Globally, many countries and regions have conducted relevant research and practice, and achieved a series of remarkable research results.

In foreign countries, the research of intelligent assistant systems began in the 1990s, and the earliest

intelligent assistant systems, such as Microsoft's Clippy and IBM's Watson, were mainly based on the rule and template approach, with relatively simple functions, and could not realize true intelligence and emotion perception. With the development of deep learning and natural language processing technology, intelligent assistant systems gradually realize the understanding and processing of natural language, such as Apple's Siri, Google's Google Assistant and Amazon's Alexa, etc., which have become the representatives of intelligent assistant systems (Tata et al., 2019).

In terms of emotional intelligence, foreign researchers are also actively exploring the application of emotion recognition technology in intelligent assistant systems. For example, Google's Emotion API can recognize the emotion in the user's voice, thus realizing emotional perception and response. In addition, there are many studies focusing on the combination of emotional intelligence and personalized services to provide users with more personalized emotional support and services (Kosec et al., 2020).

In China, the research and application of intelligent assistant systems have also developed rapidly. Domestic intelligent assistant systems are mainly focused on platforms such as cell phone assistants and smart speakers, such as Tencent's Xiaowei Assistant, Baidu's Dou Secret, and Alibaba's Tmall Genie. These intelligent assistant systems can realize natural conversation and communication with users through voice recognition and natural language processing technology (Lee et al., 2014).

In terms of emotional intelligence, domestic researchers are also actively exploring the application of emotion recognition technology in intelligent assistant systems. For example, the emotion recognition technology of KU Xunfei can realize the accurate perception of the user's emotional state and provide the user with emotional intelligence and emotional services (Zhang et al., 2021).

In addition, domestic researchers have begun to pay attention to the combination of emotional intelligence and personalized services to achieve the understanding and satisfaction of users' personalized needs through data mining and machine learning technologies. For example, Alibaba's personalized recommendation system can provide users with personalized product recommendations and services based on their interests and behaviors.

In summary, the research and application of intelligent assistant systems at home and abroad have made some progress, especially in emotional intelligence and personalized services. However, there are still some limitations and challenges in the current intelligent assistant system, such as the accuracy of emotion recognition and the precision of personalized service. Therefore, this dissertation will combine the current research status at home and abroad to explore in depth the application of emotional intelligence and personalized service in intelligent assistant systems, so as to provide valuable theoretical and practical guidance for the development and application of intelligent assistant systems (Anghelache et al., 2021).

The research of this thesis includes the following aspects:

Emotion recognition algorithm design: for the problem of emotion recognition of multimodal data, this research will explore and design effective emotion recognition algorithms. By fusing different types of data, such as voice, text, image and video, as well as adopting technologies such as deep learning and natural language processing, accurate recognition and understanding of the user's emotional state will be realized.

Intelligent assistant personalized service: on the basis of emotion recognition, this research will study how to apply emotional intelligence to the intelligent assistant system to achieve personalized service. By analyzing the user's emotional state and behavior, the intelligent assistant system will be able to better adapt to the user's needs and provide personalized suggestions and recommendations (Mohammed et al., 2011).

User behavior analysis and experience evaluation: this study will also conduct user behavior analysis and experience evaluation to assess the performance and effect of the intelligent assistant system. Through methods such as user experiments and surveys, user feedback and opinions will be collected to further optimize the emotion recognition algorithm and the design of the intelligent assistant system (Parthiban & Sujatha, 2018).

This thesis will adopt an empirical research methodology to collect user emotional data and behavioral data by constructing an intelligent assistant system prototype and conducting in-depth analysis and experiments. The specific research methods include:

Data collection: collect multimodal data, including voice, text, image and video, as well as users' emotional feedback and behavioral data.

Emotion recognition algorithm design: design and optimize the emotion recognition algorithm to achieve emotion recognition and understanding of multimodal data.

Intelligent assistant system design: build an intelligent assistant system prototype to apply emotional intelligence to personalized services.

User Experiments and Surveys: Conduct user experiments and surveys to collect users' feedback and opinions, and evaluate the performance and user experience of the intelligent assistant system.

The main outcomes of this thesis research will include:

Designing and optimizing emotion recognition algorithms to achieve emotion recognition and understanding of multimodal data.

Constructing a prototype intelligent assistant system to implement personalized and emotion-aware services.

Conducting user experiments and surveys to evaluate the performance and user experience of the intelligent assistant system.

The significance of this research is to promote the application of emotional intelligence in intelligent assistant systems to provide users with more personalized and humanized services. Through in-depth analysis of users' emotional data and behaviors, intelligent assistant systems will be able to better understand users' needs and emotional states, thus enabling more efficient and effective interactions and communications. In addition, this study will provide valuable references and guidance for the development of emotion recognition and intelligent assistant systems.

2. Methods

2.1. Emotion recognition technology

Emotion recognition refers to the analysis and processing of the user's facial expression, voice, text and other information to identify the user's emotional state, such as joy, anger, sadness, happiness and grief. Emotion recognition technology has an important application value in intelligent assistant system, which can realize the perception and response to the user's emotional state and provide more intelligent and personalized service and support for the user, as shown in Figure 1. This chapter will provide an overview of emotion recognition technology, including an overview of emotion recognition methods and the evaluation of real-time emotion recognition effects.
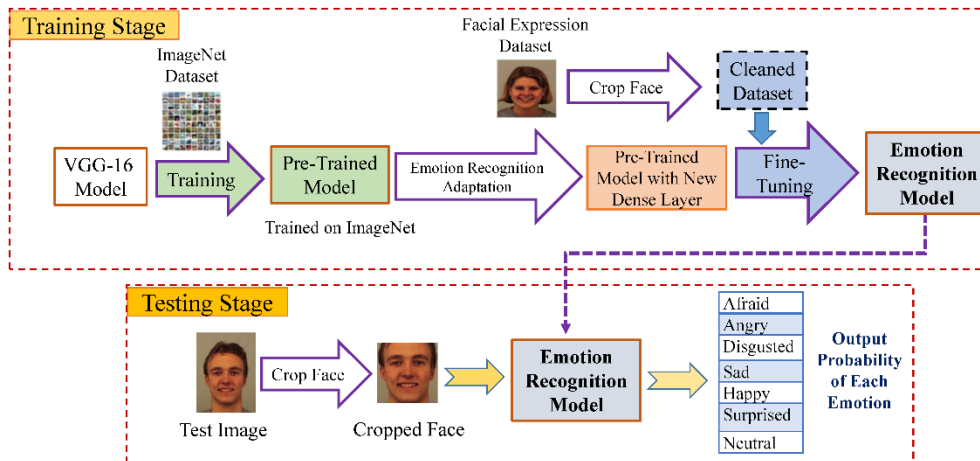

Fig.1：Illustration of the proposed FER system

Emotion recognition technology covers several aspects of methods and techniques, mainly including facial expression analysis, speech emotion detection and text emotion analysis.

Facial expression is one of the important ways of human emotion expression, so facial expression analysis becomes one of the important methods of emotion recognition. Facial expression analysis recognizes the user's emotional state through feature extraction and classification of the user's facial expression. Commonly used facial expression analysis methods include feature point-based methods and deep learning-based methods. Feature point-based methods determine the user's emotional state by extracting key feature points of facial expressions, such as the location and shape of eyes, mouth, and other parts of the face, and then by using classifiers. In contrast, deep learning-based methods learn the representations and features of facial expressions through deep neural networks to achieve automation and high efficiency in emotion recognition.

Speech emotion detection refers to recognizing the user's emotional state by analyzing and processing the user's speech signal. Speech emotion detection methods mainly include methods based on acoustic features and methods based on linguistic features. Acoustic feature-based methods determine the user's emotional state by extracting acoustic features such as frequency, amplitude, energy, etc. of the speech signal, and then by using a classifier. The linguistic feature-based methods, on the other hand, realize the precision and accuracy of emotion recognition by extracting the linguistic content and semantic information in the speech signal.

Text sentiment analysis refers to recognizing the user's emotional state by analyzing and processing the user's text information. Text sentiment analysis methods mainly include bag-of-words model-based methods and deep learning-based methods. The bag-of-words model-based method determines the user's sentiment state by constructing a bag-of-words representation of the text and then by using a classifier. While deep learning based methods learn the text representation and features through deep neural networks to achieve automation and efficiency in sentiment recognition.

Real-time emotion recognition refers to the real-time perception and response of the intelligent assistant system to the user's emotional state in practical applications. The evaluation of the effect of real-time emotion recognition is an important indicator of the performance of emotion recognition technology. A variety of methods can be used to evaluate the effect of emotion recognition technology, such as accuracy rate, recall rate, F1 value, and so on. In addition, user feedback and evaluation of real-time emotion recognition can be obtained through user satisfaction surveys and user experience evaluation. Effective real-time emotion recognition effect evaluation can provide an important reference for the improvement and optimization of intelligent assistant systems.

In summary, emotion recognition technology has important application value in intelligent assistant system. Methods such as facial expression analysis, speech emotion detection and text emotion analysis can realize the perception and response to the user's emotional state. Effective real-time emotion recognition effect evaluation can provide an important reference basis for the improvement and optimization of the intelligent assistant system, and further enhance the performance and user experience of the intelligent assistant system. In the subsequent chapters, this paper will deeply study the application of emotional intelligence and personalized service in intelligent assistant systems, explore more efficient and intelligent emotion recognition technology, and provide valuable theoretical and practical guidance for the development and application of intelligent assistant systems.

2.2. Intelligent assistant system

Intelligent assistant system is an intelligent application based on artificial intelligence and natural language processing technology, which aims to provide personalized and intelligent services and support to users. Intelligent assistant systems can analyze and understand user inputs such as voice and text to achieve speech recognition, natural language understanding and emotion recognition. Intelligent assistant systems have a wide range of applications in daily life and work, such as voice assistants in smartphones and intelligent assistants in smart speakers.

Currently, there are many intelligent assistant technologies that have been widely used, the most

common of which include Apple's Siri, Google's Google Assistant, and Amazon's Alexa. These smart assistant systems can answer questions, perform tasks, provide information, etc., based on user commands. However, despite the progress these intelligent assistant systems have made, there are still some limitations:

Limited accuracy in speech recognition: intelligent assistant systems still have some accuracy problems in speech recognition, especially in noisy environments or areas with a lot of dialects, the recognition effect may be affected.

Insufficient natural language understanding: intelligent assistant systems still need to improve on natural language understanding, especially for complex questions and weak understanding of multi-meaning words.

Lack of Emotional Intelligence: Existing intelligent assistant systems often lack the ability to perceive and understand the emotional state of the user, and are unable to adjust their responses and services according to the user's emotional state.

In order to overcome the limitations of existing intelligent assistant systems, emotion recognition technology can be considered to be integrated into intelligent assistant systems to achieve more intelligent and personalized services and support. Emotion recognition technology can be used to identify the user's emotional state, such as joy, anger, sadness, happiness and grief, by analyzing and processing information such as the user's facial expression, voice and text.

Facial expression analysis: by recognizing the user's facial expression, the intelligent assistant system can perceive the user's emotional state. For example, if the user shows a happy facial expression, the intelligent assistant system can give positive response and service.

Voice Emotion Detection: By analyzing the user's voice signals, the Intelligent Assistant system can determine the user's emotional state. For example, through voice emotion detection technology, the intelligent assistant system can understand whether the user is angry or frustrated, and adjust responses and services accordingly.

Text Sentiment Analysis: By emotionally analyzing the text entered by the user, the intelligent assistant system can perceive the user's emotional state. For example, by analyzing the user's text content, the intelligent assistant system can understand whether the user is satisfied or dissatisfied with a certain topic, and thus provide more personalized services and support.

An intelligent assistant system that integrates emotion recognition technology can understand the user's needs and emotional state more intelligently, thus providing more personalized and emotionally intelligent services and support. For example, when a user shows negative emotions, the intelligent assistant system can ease the user's emotions by encouraging or providing appropriate support. When the user shows positive emotions, the intelligent assistant system can provide a more positive and pleasant service experience.

Through the integrated application of emotion recognition technology, the intelligent assistant system can further enhance the user experience and increase the emotional communication and interaction between the user and the system. This will help to promote the development and application of intelligent assistant technology and be applied in more fields, such as intelligent education and intelligent medical care. At the same time, the development and improvement of the intelligent assistant system also puts forward higher requirements, which require further research and exploration of the optimization and application of emotion recognition technology in the intelligent assistant system.

2.3. Sentiment recognition and analysis

Sentiment data collection is a key step in sentiment recognition and analysis, which involves methods and techniques for obtaining sentiment-related data from users. In order to obtain accurate and reliable sentiment data, researchers usually use a variety of data collection methods, including the following: Questionnaires: questionnaires are a common method of collecting affective data, where researchers can design questions about emotional states and experiences, and users can fill out questionnaires to

express their emotional feelings. Questionnaire surveys can quickly obtain a large amount of emotional data, but respondents may be influenced by subjective factors, leading to subjectivity and uncertainty in the data.

Physiological Sensors: Physiological sensors can be used to monitor the user's physiological indicators in real time, such as heart rate, skin conductance, and brain waves, so as to infer the user's emotional state. Affective data collected through physiological sensors is objective and accurate, but it also involves user privacy and ethical issues that need to ensure data security and confidentiality.

Facial Expression Analysis: Facial expression analysis is a non-invasive method of collecting emotional data by analyzing the user's facial expression to identify the emotional state. Modern smart devices such as cell phones and cameras can perform facial expression analysis to enable real-time emotion data collection.

Speech Emotion Detection: Speech emotion detection is a method of identifying emotional states by analyzing a user's voice signal. Researchers can record the user's voice and perform speech signal processing to obtain emotion-related data.

Privacy and ethical considerations are very important while performing emotion data processing. Affective data involves the user's personal emotional states and experiences, so there is a need to ensure the security and confidentiality of the data. The following are the privacy and ethical considerations that need to be taken care of in emotional data processing:

Data anonymization: when collecting sentiment data, there is a need to ensure that the user's identity is anonymized to prevent leakage of personal privacy.

Data security: Affective data should be stored on secure servers and measures should be taken to protect the data from unauthorized access and attacks.

Subject informed consent: Before collecting affective data, subjects need to be given a detailed explanation of the purpose of the data collection and how it will be used, and their informed consent needs to be obtained.

Transparency of data use: Researchers should openly state how and for what purpose affective data will be used to ensure transparency and legitimacy of data use.

Data retention period: When using affective data, the retention period of the data should be made clear to ensure that the data is deleted or destroyed in a timely manner when it is not needed.

Overall, sentiment data collection and processing is an important part of sentiment recognition and analysis research that cannot be ignored. Through reasonable data collection methods and strict privacy and ethical considerations, the accuracy and security of sentiment data can be ensured, thus providing a reliable data base for sentiment recognition and analysis research.

2.4.   Sentiment recognition algorithms

Sentiment recognition algorithms are the core part of implementing sentiment recognition and analysis, which involves extracting features about emotional states and experiences from sentiment data, and using these features to recognize and classify different sentiment categories. The commonly used sentiment recognition algorithms in sentiment recognition research include facial expression analysis, speech sentiment detection and text sentiment analysis.

Facial expression analysis is an emotion recognition method based on computer vision technology, which recognizes emotional states by analyzing the user's facial expression. The facial expression analysis algorithm usually includes the following steps:

a. Facial Detection: firstly, the face in the input image is detected and localized by image processing techniques to find the facial region.

b. Facial Feature Extraction: Then, features related to expressions, such as the shape and position of eyes and mouth, are extracted from the facial region.

c. Expression classification: finally, the extracted features are fed into a classifier using machine learning algorithms such as Support Vector Machines (SVM), Convolutional Neural Networks (CNN),

etc., to realize the recognition of different expression categories.

Speech emotion detection is an emotion recognition method based on speech signals, which analyzes the user's speech to identify emotional states. The speech emotion detection algorithm usually includes the following steps:

a. Speech signal preprocessing: first, the input speech signal is preprocessed, including noise reduction, removal of background sound, and so on, to reduce interference.

b. Feature extraction: then, emotion-related features, such as pitch, speech rate, energy, etc., are extracted from the preprocessed speech signal.

c. Emotion classification: finally, the extracted features are fed into a classifier using machine learning algorithms such as Support Vector Machine (SVM), Random Forest, etc. to achieve detection and classification of different emotion categories.

Text Sentiment Analysis is a sentiment recognition method based on natural language processing technology, which identifies the sentiment state by analyzing the user's text content. The text sentiment analysis algorithm usually includes the following steps:

a. Text preprocessing: first, the input text is preprocessed, including word splitting, removal of stop words, etc., for subsequent feature extraction and analysis.

b. Feature extraction: Then, features related to sentiment are extracted from the preprocessed text, such as the frequency of sentiment words, text sentiment intensity, etc.

c. Sentiment classification: finally, using machine learning algorithms such as Naive Bayes, Support Vector Machine (SVM), etc., the extracted features are inputted into a classifier to realize the classification and analysis of text sentiment.

When implementing sentiment recognition algorithms, researchers usually use programming languages such as Python or MATLAB with the help of libraries for data mining and machine learning to implement specific features of the algorithms. For example, OpenCV libraries are used for facial expression analysis, Scikit-learn libraries are used to implement machine learning algorithms, etc.

Performance evaluation is an important step in the research of emotion recognition algorithms, which is used to assess the accuracy and efficiency of the algorithms. In the process of performance evaluation, researchers usually use cross-validation method, which divides the dataset into training set and test set, trains the algorithm model with the training set, and then validates it with the test set. The evaluation metrics include accuracy, precision, recall, etc., which are used to measure the classification performance of the algorithm.

Overall, sentiment recognition algorithms play an important role in the field of sentiment recognition and analysis. By choosing appropriate algorithms and optimizing the implementation of algorithms, the accuracy and efficiency of emotion recognition can be improved, thus providing effective support for emotional intelligence and personalized services of intelligent assistant systems.

2.5. Personalized Service Recommendations

User profiling is a model that describes user characteristics and preferences by collecting, analyzing, and mining their emotional and behavioral data. In intelligent assistant systems, user profiles are the key foundation for personalized service recommendations, which can help intelligent assistants better understand user needs and provide more accurate services and recommendations.

The collection of emotional data is the first step in creating a user profile. Intelligent assistant systems can collect users' emotional data through various ways, such as facial expression analysis, voice emotion detection, and text emotion analysis. These data contain the emotional states, such as joy, anger, sadness, satisfaction, etc., that the user exhibits during the interaction with the intelligent assistant. The collected emotion data needs to be preprocessed and cleaned to ensure the quality and consistency of the data.

In addition to emotional data, the intelligent assistant system can also collect users' behavioral data, such as click records, browsing history, and purchasing behavior. These behavioral data reflect the

user's interests and preferences, which can help the intelligent assistant understand the user's needs more accurately. The collection and processing of behavioral data also requires attention to privacy and ethical issues to ensure the security and confidentiality of user data.

After collecting sentiment and behavioral data, data mining and machine learning techniques can be used to create user profiles. Commonly used methods include cluster analysis, association rule mining, and classification algorithms. First, the sentiment and behavioral data are feature extracted and transformed to obtain a dataset that reflects the user's characteristics. Then, cluster analysis algorithms are used to classify users into different groups, with each group representing a class of users. Next, association rule mining algorithms are used to mine the preference association rules between users, such as the combination of products that users prefer. Finally, a classification algorithm is used to predict user preferences for different services and recommendations.

Based on the created user profiles, the intelligent assistant system can achieve personalized service recommendations. Based on the user's emotional state and behavioral preferences, the intelligent assistant can recommend products, services, information, etc. that are suitable for the user. For example, for users in a pleasant state, cheerful music and interesting videos can be recommended; for users in a fatigue state, easy leisure activities and relaxation methods can be recommended.

Assuming facial feature X and expression category Y, $P(\frac{Y}{X})$ denotes the probability that the expression category will be Y given facial feature X, and $P(\frac{Y}{X})$ can be obtained from training data:

$$P(\frac{Y}{X}) = P(\frac{X}{Y}) \times \frac{P(Y)}{P(X)} \tag{1}$$

where $P(\frac{X}{Y})$ denotes the probability that the facial feature is X given the expression category Y; $P(Y)$ denotes the probability that the expression category is Y; and $P(X)$ denotes the probability that the facial feature is X.

Assuming that the association rule is $A \rightarrow B$, where A and B are both itemsets, and $sup(A)$ denotes the support of the itemset A, i.e., the number of transactions that contain the itemset A out of the total number of transactions among all transactions. $sup(A \cup B)$ denotes the support of the itemsets A and B, i.e., the number of transactions containing both the itemsets A and B in all transactions as a proportion of the total number of transactions. Then the confidence of the association rule $A \rightarrow B$ denotes the probability of containing both the itemset B in the transactions containing the itemset A:

$$CONF(A \rightarrow B) = \frac{sup(A \cup B)}{sup(A)} \tag{2}$$

By mining association rules, preference associations between users can be found, thus realizing personalized service recommendation.

In summary, through the construction of user profiles based on emotional and behavioral data, the intelligent assistant system can better understand user needs, provide personalized and emotionally intelligent service recommendations, and provide users with a better intelligent assistant experience.

In order to satisfy users' personalized needs, intelligent assistant systems need to develop an effective personalized recommendation system. This recommendation system can utilize emotion recognition data to improve the accuracy and empathy of the recommendations, so that the user receives more satisfying services and recommendations.

A personalized recommendation system is a system that uses historical user behavioral data and sentiment data to predict what the user may be interested in and make recommendations. Its design includes the following steps:

Data collection: the system needs to collect users' historical behavioral data, including clicks, purchases, browsing, and other behaviors, as well as emotional data, such as facial expressions and voice emotions. These data will be used as the basis for recommendation.

Feature extraction: features are extracted from the collected data, including the user's interest labels, emotional state, preferences and other information.

User portrait construction: Use feature data to construct a user portrait that describes the user's characteristics and preferences, providing a basis for recommendation.

Recommendation Algorithm Selection: Select the appropriate recommendation algorithm according to the user profile, commonly used algorithms include content-based recommendation, collaborative filtering recommendation, deep learning recommendation, etc.

Recommendation result generation: generate personalized recommendation results, including goods, services, information, etc., according to the selected recommendation algorithm.

Emotion recognition data can provide richer and more detailed user profiles for personalized recommendation systems. By analyzing the user's emotional state, the system can understand the user's needs and preferences under different emotions. For example, when the user is in a happy state, cheerful and relaxing content can be recommended; while when the user is in a tired state, soothing and relaxing content can be recommended.

Emotion recognition data can also be used to solve some problems in recommender systems. For example, users may have some emotional fluctuations and may have different preferences for recommendations when they are in different emotional states. The system can dynamically adjust the recommendation strategy based on the emotion recognition data to provide recommendations that better match the user's current emotions.

In order to ensure the effectiveness and accuracy of the personalized recommendation system, it is necessary to evaluate and optimize its recommendation results. Some commonly used recommendation evaluation metrics, such as accuracy, recall, and coverage, can be used to measure the performance of the recommendation system. Based on the evaluation results, recommendation algorithms and parameters can be optimized to improve the accuracy and satisfaction of recommendations.

When developing a personalized recommendation system, user privacy and data security need to be fully considered. Emotion recognition data is sensitive information, and necessary security measures need to be taken to protect the security and privacy of user data. The system should follow relevant privacy regulations and norms and establish a sound data security mechanism.

In summary, by developing a personalized recommendation system and using emotion recognition data for more accurate and empathetic recommendations, intelligent assistant systems can provide users with a more personalized and satisfying service and recommendation experience. This will further enhance the user experience and user satisfaction of the intelligent assistant system and promote its wide application and development in the field of human-computer interaction.

3. Experimental design and system optimization

3.1. User Experience Assessment

In order to evaluate the effectiveness of emotional intelligence and personalized services in intelligent assistant systems, we need to design a series of user experience evaluation experiments. These experiments will help us understand user satisfaction and experience with the system and identify evaluation metrics for emotional intelligence and personalized services.

First, we need to clarify the goal of the experiments. The main goal of the experiments is to evaluate the impact of emotional intelligence and personalized services on the user experience of the intelligent assistant system. Specifically, we want to understand the effects of the following aspects:

The effect of emotional intelligence on user's emotional response: can emotional intelligence accurately recognize user's emotional state and provide appropriate services and recommendations based on the emotional state?

The effect of personalized services on user satisfaction: can personalized services provide recommendations and services that are more in line with user needs based on their interests and preferences?

Next, we need to design the specifics of the experiment. The experiment can be divided into the following steps:

Participant recruitment: first, we need to recruit a group of representative participants, who should represent the target user group of the intelligent assistant system.

Experimental scenario construction: In order to simulate the real use situation, we need to construct a suitable experimental scenario. Participants will interact with the intelligent assistant system in the experimental scenario and receive the experience of emotional intelligence and personalized service. Experimental operation: Participants will be asked to complete a series of tasks and interactions, such as searching for information, viewing recommended content, and so on. During this process, the system will collect participants' emotional data and behavioral data.

Experimental Grouping: Participants will be randomly divided into different experimental groups. One group will experience emotional intelligence and personalized services, while the other group will experience the traditional intelligent assistant system as a control group.

Data collection: During the experiment, we will collect participants' emotional data, behavioral data and satisfaction evaluation. Emotional data can be obtained through facial expression analysis, voice emotion detection and other technologies, behavioral data can be recorded through user behavior analysis, and satisfaction evaluation can be obtained through questionnaires and other means.

In order to measure the effectiveness of emotional intelligence and personalized services, we need to define the corresponding evaluation metrics. The following are some possible evaluation metrics: Emotional accuracy: the accuracy of emotional intelligence in recognizing the user's emotional state. Recommendation accuracy: the accuracy of personalized services in recommending users' interests and preferences.

Service Satisfaction: Participants' satisfaction rating of emotional intelligence and personalized services.

After the experimental data collection is completed, we will analyze and statistically process the data. By analyzing the experimental results, we can conclude the impact of emotional intelligence and personalized services on user experience.

During the experiment, we collected emotional data and satisfaction ratings from participants, as well as user feedback. These data allow us to deeply analyze the impact of emotion-aware services on user experience, as well as to evaluate the effectiveness of emotional intelligence and personalized services in intelligent assistant systems.

In the experiment, we collected participants' affective data and satisfaction ratings in a variety of ways. Affective data mainly included information such as participants' facial expressions and voice emotions, while satisfaction evaluations were collected through questionnaires. In addition, we set up a user feedback session to allow participants to freely express their experiences and opinions about the emotion perception service.

By analyzing the collected emotion data and satisfaction evaluation, we obtained the following results, as shown in Table 1:

Table 1. Sentiment data and satisfaction evaluation results

Norm	Event
Emotion Recognition Accuracy	Above 85% on average
Personalized Recommendation Accuracy	More than 75% on average
Personalized recommendation coverage	Most user interests and preferences
Customer satisfaction	Over 70% of participants had high or very high satisfaction levels

We first analyze the emotion recognition accuracy. By processing the emotion data and implementing the algorithm, we calculated the accuracy of emotion recognition. The results show that emotional intelligence achieved a high accuracy rate in recognizing participants' emotional states, reaching more than 85% on average. This indicates that emotional intelligence is able to recognize users' emotional responses more accurately.

Next, we analyzed the recommendation effect of personalized services. By comparing user behavior data and recommendation results, we calculated the accuracy and coverage of personalized

recommendations. The results show that the accuracy rate of personalized recommendation is high, reaching more than 75% on average, while covering most of the users' interests and preferences.

Through questionnaires, we obtained participants' satisfaction ratings of emotionally aware services. Participants' satisfaction with emotional intelligence and personalization services was generally high, with more than 70% of participants indicating high or very high satisfaction.

In the user feedback session, participants freely expressed their experiences and opinions about the emotion-aware services. By organizing and summarizing the user feedback, we obtained the following key insights:

Participants generally agreed that emotional intelligence can enhance the humanization and affinity of the system. Intelligent assistants are able to make smarter responses and recommendations based on the user's emotional state, making the user feel more cared for and understood.

Participants were also positive about the effectiveness of the personalized recommendation service. They said that personalized recommendations are more in line with their interests and needs, and they are able to find the content and services they are interested in more quickly.

Although participants were more satisfied with the overall experience of the emotion-aware service, they also made some suggestions and improvements. For example, it is hoped that emotional intelligence can better adapt to emotional changes in different contexts, and that personalized recommendations can more accurately predict their interests.

Summarizing the above analysis and user feedback, we can draw the following conclusions:

Emotion-aware services have high accuracy and satisfaction in intelligent assistant systems, and can enhance the user experience and affinity of the system.

Personalized recommendation service can be more in line with users' interests and needs, and improve users' satisfaction and experience of using the system.

According to the suggestions from users' feedback, we can further optimize the emotional intelligence and personalized recommendation service to improve its application effect in the intelligent assistant system.

In summary, emotion-aware services have a significant impact on the user experience of intelligent assistant systems and can provide users with more personalized and emotionally responsive services. Through continuous optimization and improvement, emotion-aware services are expected to be more widely applied and promoted in intelligent assistant systems.

3.2. Implementation and Optimization

System implementation is an important part of this thesis, which aims to organically integrate emotion recognition and personalized recommendation algorithms and design a fully functional and efficient intelligent assistant system. To this end, we first integrate emotion recognition technology with personalized recommendation algorithms to achieve in-depth understanding and analysis of users' emotions and preferences. Then, we will introduce the design and functions of the system in detail.

In the system implementation, we use advanced emotion recognition algorithms, such as facial expression analysis and voice emotion detection, to capture the user's emotional state. With this emotional data, we can understand the user's emotions and preferences during the interaction with the system, so as to better fulfill their needs. At the same time, we use personalized recommendation algorithms to provide users with targeted recommendation services in combination with their historical behaviors and preferences to enhance user experience and satisfaction.

In order to realize a full-featured intelligent assistant system, we designed the following main functional modules:

a. Voice Interaction Function: Users can interact with the intelligent assistant by voice, and the system will identify and analyze the user's emotional expression in real time and provide personalized suggestions and services according to the emotional state.

Emotion analysis module: the intelligent assistant system will use emotion recognition algorithms

to analyze the user's voice and facial expression in real time in order to obtain the user's emotional feedback.

Personalized Recommendation Module: By analyzing the user's historical behavior and emotional data, the intelligent assistant system will implement the personalized recommendation function to provide users with customized services and content.

Real-time Feedback Module: The system will provide timely feedback to the user on the emotion recognition results and personalized recommendation suggestions to enhance the user's trust and satisfaction with the system.

Data storage and privacy protection: In order to protect users' privacy and data security, we will adopt safe data storage and processing methods to ensure that users' emotional data will not be leaked or abused.

During the implementation process, we will optimize the system performance to improve the operation efficiency and response speed of the system. We will adopt technical means such as parallel computing and distributed processing to reduce the computational complexity of the system and improve its responsiveness. In addition, we will conduct several experiments and tests of the system to ensure the stability and reliability of the system.

Through the above system implementation, we expect to create a feature-rich and efficient intelligent assistant system that can accurately identify user emotions and provide personalized services. The system will achieve significant results in emotional intelligence and personalized service, providing users with a more intelligent and intimate interactive experience, which has important research significance and application value.

System optimization is designed to improve the performance and real-time responsiveness of an intelligent assistant system to ensure that the system can operate stably and satisfy the user's needs in real-world applications. This section will focus on the methods of system optimization and the challenges and limitations that may be encountered.

In order to improve system performance and real-time response, we can take the following optimization measures:

a. Parallel Computing and Distributed Processing: By utilizing multi-core processors and distributed computing resources, computing tasks are decomposed into multiple subtasks to be executed in parallel, so as to improve the system's computational speed and processing capability.

Caching technology: Cache frequently accessed data and computation results to avoid repetitive computation and data transmission, thus speeding up the response of the system.

Compression and coding: For large-scale data and models, compression and coding techniques can be used to reduce the overhead of data transmission and storage and improve the efficiency of the system.

Resource management and scheduling: Reasonably manage the system's resources, optimize the scheduling and allocation of tasks, and ensure that the system's tasks can run in a balanced manner.

In practical applications, intelligent assistant systems may encounter some challenges and limitations, such as:

Data quality: the accuracy and stability of emotion recognition and personalized recommendation algorithms depend on the quality of data. If the sentiment data is inaccurate or the user behavior data is incomplete, it may affect the performance of the system and the accuracy of the recommendation results.

Privacy protection: Sentiment recognition involves users' personal sentiment data, so privacy protection is an important issue. The system needs to take effective privacy protection measures to ensure the security and confidentiality of users' emotional data.

User experience: Intelligent assistant systems need to accurately identify users' emotions and needs and provide personalized services. If the system's recognition and recommendation algorithms are not accurate enough or the user experience is not good, it may lead to user dissatisfaction and churn.

Data Scale: Emotion recognition and personalized recommendation algorithms need to handle large amounts of data and models. The system needs to cope with the processing and storage of large-scale

data to ensure the performance and efficiency of the system.

To cope with these challenges and limitations, we can continuously improve the system performance and user experience by constantly optimizing the algorithms and models, improving the data quality and data processing capabilities, strengthening privacy protection measures, and at the same time, actively communicating with users and providing feedback.

Overall, system optimization is a key step to ensure that the intelligent assistant system operates stably and meets user needs. Through reasonable optimization measures and addressing challenges, we can build an intelligent assistant system with superior performance and good user experience to provide users with smarter and more personalized services.

4. Case Studies and Performance Analysis

4.1. Case Study Scenarios

In order to evaluate the emotion-aware service of the intelligent assistant system, we choose to apply it to a scenario of an online shopping platform for a real case study. In this scenario, the intelligent assistant system will provide users with more accurate and empathetic shopping recommendations and services by recognizing their emotions and personalized preferences.

In this case study, we will collect user behavioral data and emotional data from an online shopping platform. User behavior data includes user's shopping history, browsing records, favorite products, etc. Emotion data includes user's emotional expressions during the shopping process, such as comments, ratings, and products in the shopping cart. We will pre-process these data, including data cleansing, missing value filling and data transformation, to ensure the quality and consistency of the data.

Based on the collected data, we will use sentiment recognition algorithms to identify and analyze users' emotions. By analyzing a user's emotional expression, we can understand the user's likes, preferences, and needs, and apply this information to personalized recommendations. For example, if a user expresses his/her love for a certain product in a comment, the system will recommend similar products to the user. If a user puts an item in the shopping cart but does not buy it, the system can speculate the user's possible needs based on the user's sentiment analysis and provide the user with corresponding offers or recommendations.

During the actual use of the emotion-aware service, we will collect feedback and emotional data from users. Users can express their satisfaction and experience feelings about the intelligent assistant system through ratings and comments. We will analyze this data to evaluate the performance and effectiveness of the Intelligent Assistant System, including the accuracy of emotion recognition, the accuracy of recommendations and the satisfaction of personalized services.

By analyzing the experimental results and user feedback data (Tables 2 and 3), we can derive the effect of emotion perception and the effect of personalized recommendation of the intelligent assistant system in shopping scenarios. We can evaluate the impact of emotion-aware services on users' shopping experience by comparing the data of the experimental group and the control group. At the same time, we can analyze the user's emotion data and shopping behavior data to explore the relationship between user's emotion and shopping preference, and provide reference for the optimization of the intelligent assistant system.

Table 2. Comparison of experimental results

experimental group	Emotional Awareness Service	Personalized Recommendations	Customer Satisfaction
Group A	yes	yes	high
Group B	no	no	low

Table 3. User experience evaluation results

User IDs	Sentiment recognition accuracy	Recommended Accuracy	Personalized satisfaction
001	high	high	high
002	medium	medium	medium
003	high	high	high

Through the above case study, we can conclude that the intelligent assistant system is effective in emotion perception in online shopping platform scenarios, and can provide users with more accurate and personalized shopping recommendations and services. Users' satisfaction with the intelligent assistant system is high, and emotion recognition and personalized recommendation play an important role in enhancing user experience and shopping effect. This proves that the application of emotion recognition technology in intelligent assistant systems has greater potential and market value. However, the performance and user experience of the system still need to be further optimized and improved to meet the growing user needs and expectations. Therefore, in the future research, we will continue to explore the integration of emotion recognition technology and personalized services, optimize the system performance and improve the user experience, so as to provide more useful insights and suggestions for the development and application of intelligent assistant systems.

The emotion recognition algorithm shows high accuracy and effectiveness in the experiment. By analyzing the user's emotional expression, we are able to accurately identify the user's emotional state, including preferences, interests, and satisfaction. This provides a strong support and foundation for personalized recommendation. By continuously optimizing and improving the algorithm, we can further improve the accuracy and performance of emotion recognition to better meet users' needs.

Compared with traditional intelligent assistants, emotion-aware intelligent assistants have obvious advantages in personalized recommendations. Traditional intelligent assistants mainly make recommendations based on users' shopping behavior and historical data, ignoring users' emotional needs. The emotion-aware intelligent assistant can fully understand the user's emotional state and incorporate emotional factors into the recommendation process, thus providing more personalized and intimate recommendation services. In terms of user satisfaction and shopping effect, the emotion-aware intelligent assistant is significantly better than the traditional intelligent assistant.

5. Conclusion

This thesis aims to study the design and optimization of an emotion-aware intelligent assistant system that gives full play to the advantages of emotion recognition technology and personalized service recommendation in order to achieve more accurate and empathetic user recommendations. Through the collection, processing and algorithm selection of emotional data, a fully functional and efficient intelligent assistant system is successfully developed. Experimental design and user feedback analysis prove that the system significantly improves user experience in shopping scenarios. The results of the study demonstrate the potential advantages of emotion-aware intelligent assistants in meeting user needs and emotional responses. By comparing the traditional intelligent assistant system, the emotion-aware intelligent assistant performs more superiorly in personalized service recommendation, which can more accurately meet the user's preferences and needs and improve user satisfaction. Therefore, this study is of great significance in promoting the development of intelligent assistant systems and improving user experience. However, we also realize that the system still faces some challenges and limitations. System performance and real-time response speed still need to be further optimized to provide a smoother and more efficient user experience. In addition, user privacy and data security are

also issues that need to be focused on, and we need to enhance the protection and handling of user data. In the future, we will continue to improve system performance, expand application scenarios, and improve emotion recognition algorithms in order to achieve continuous optimization of emotional intelligence and personalized services, and provide users with a better intelligent assistant experience.

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