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A DEEP LEARNING FACIAL EXPRESSION RECOGNITION BASED SCORING SYSTEM FOR RESTAURANTS

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ABSTRACT

Recently, the popularity of automated and unmanned restaurants has increased. Due to the absence of staff and improper feedback mechanism there is no direct perception of the customers' impressions in order to find out their experience with the restaurant. Therefore the aim of our project is to develop a rating system based on facial expression recognition using deep learning to assess the customers remarks with their food. We used python to create a user interface which takes a picture of the customer and is then used by the models, Haar Cascade and Convolution Neural Network for facial detection and emotion recognition respectively. Later the food will be automatically rated into any one of the three expressions sad, neutral and happy. This purposed methodology undergoes several phases such as image processing, facial identification, facial feature extraction, emotion classification and prediction to give an accurate facial expression feedback.

KEY WORDS -- Haar Cascade, Convolutional Neural Network (CNN), Facial Detection, Image Processing, Emotion Classification, Food Rating System.

1.INTRODUCTION

In today's highly competitive restaurant industry, providing exceptional customer service is vital for business success. Traditional methods of gathering customer feedback, such as surveys or comment cards, are limited by subjective interpretation and are often slow to capture real-time sentiment. To address this, a new paradigm of customer feedback is emerging through the use of deep learning technologies,

particularly for facial expression recognition. This novel approach promises to offer more accurate, timely, and actionable insights into customer satisfaction, leading to a more personalized dining experience.

A deep learning facial expression recognition system for restaurant scoring is a forward-thinking approach that involves using advanced computer vision techniques and machine learning algorithms to analyze and score customer emotions in real time. By leveraging facial expressions, which are universal indicators of human emotions, the system can provide a more granular understanding of customer experiences, leading to better service quality and operational improvements. The underlying technology behind this system includes convolutional neural networks (CNNs) and other deep learning models, which are particularly adept at image recognition tasks.

The primary goal of this system is to monitor customers' facial expressions during their time in the restaurant, analyze their emotional responses, and provide an overall satisfaction score based on these expressions. Unlike traditional scoring systems that rely on post-visit surveys or feedback forms, this approach offers an immediate and non-intrusive method for gauging customer sentiment. The system can also identify specific emotions such as happiness, frustration, or surprise, which can be further correlated with the quality of service, food, ambiance, and other key factors affecting customer satisfaction.

Facial expression recognition involves detecting subtle facial movements that are linked to different emotional states. For instance, a smile can indicate happiness or satisfaction, while furrowed brows may suggest dissatisfaction or confusion. By analyzing these micro-expressions, the system can provide a real-time analysis of the customer's experience, which restaurant management can use to make immediate adjustments. These insights enable restaurants to not only react to customer feedback but to proactively enhance service quality.

In addition to real-time customer feedback, the system can also serve as a valuable tool for improving employee performance. By scoring the emotional responses of customers, the system can offer suggestions on areas of improvement for staff interactions, food quality, or atmosphere. For example, if a customer's facial expression indicates dissatisfaction, the restaurant can analyze whether the issue stems from a delay in service, food quality, or another factor.

This system is designed to seamlessly integrate with existing restaurant management platforms, enhancing operational efficiency while ensuring that customer experiences are continuously monitored and improved. Furthermore, it represents a breakthrough in customer experience management, allowing businesses to move beyond traditional feedback mechanisms and leverage advanced AI-driven technologies to enhance

both customer satisfaction and business performance.

2.RELATED WORK

Facial expression recognition is a well-researched domain within the field of computer vision and machine learning. Over the years, a wide range of approaches has been developed to detect and analyze facial expressions, with deep learning emerging as one of the most effective techniques. Early methods relied heavily on hand-crafted features and classical machine learning models, but these have since been replaced by more robust deep learning models that can automatically learn the relevant features from data.

In the context of customer experience, several studies have investigated the use of facial expression recognition to gauge emotions and provide insights into customer satisfaction. For example, Liu et al. (2019) explored how facial expression analysis could be used to assess customer satisfaction in retail environments. The study showed that real-time analysis of customer facial expressions provided valuable data that could be used to adjust service quality immediately. Similarly, Hu et al. (2020) implemented facial expression recognition in an amusement park setting to measure visitor satisfaction, demonstrating the potential for deep learning models to enhance customer experience management in diverse industries.

One of the key advancements in facial expression recognition has been the development of convolutional neural networks (CNNs) and other deep learning models. These models are particularly well-suited for image-based tasks due to their ability to automatically extract relevant features from images. Zhang et al. (2018) developed a CNN-based model for facial expression recognition that achieved state-of-the-art performance on standard benchmark datasets. The success of such models has paved the way for their application in real-world scenarios, including customer experience analysis in the hospitality industry.

Another important aspect of facial expression recognition in customer service is its integration with sentiment analysis systems. Sentiment analysis, which involves analyzing customer feedback to assess the emotional tone, has been widely used in social media monitoring and online reviews. Combining sentiment analysis with facial expression recognition creates a powerful tool for understanding both the verbal and non-verbal aspects of customer feedback. Wang et al. (2019) explored this hybrid approach, showing how facial expressions and text-based sentiment analysis could be used together to improve customer service in various sectors.

3.LITERATURE SURVEY

Over the years, several advancements have been made in the application of facial expression recognition in various industries, including restaurants and hospitality. The application of deep learning for facial expression recognition is gaining

momentum due to its ability to accurately detect subtle emotional cues from facial features.

Liu et al. (2018) introduced a real-time emotion detection system using convolutional neural networks (CNNs) that was able to classify facial expressions with high accuracy. Their system demonstrated significant potential for use in customer service applications, offering real-time insights into customer emotions. In a similar study, Zhang et al. (2019) utilized deep learning to build a facial emotion recognition system for an automated customer service platform, achieving excellent performance in terms of recognizing emotions like happiness, surprise, and anger.

In the context of restaurants, Lee et al. (2020) developed a facial expression recognition system to improve dining experiences. Their work highlighted how real-time facial expression analysis could enhance personalized customer service by immediately identifying unhappy or dissatisfied customers. They implemented an emotion detection model using CNNs, which allowed restaurant staff to take proactive measures to improve customer satisfaction.

Beyond facial expressions, sentiment analysis has been integrated with facial recognition systems to create a hybrid approach for analyzing customer feedback. This combination allows for a more comprehensive understanding of customer satisfaction by taking both verbal and non-verbal cues into account. For example, an innovative approach by Chen et al. (2021) combined facial expression recognition with sentiment analysis from customer reviews. The system was capable of identifying customers' underlying emotions from both face and text-based data, thus offering a more complete and accurate assessment of customer sentiment.

4.METHODOLOGY

The development of a deep learning facial expression recognition-based scoring system for restaurants involves several steps, including data collection, model training, and system integration.

1. **Data Collection**: The first step involves gathering facial expression datasets. A variety of public facial expression datasets such as FER-2013, AffectNet, or CK+ can be used for training. These datasets contain labeled images of facial expressions that represent different emotions such as happiness, anger, sadness, and surprise. For this project, custom datasets can also be collected by recording video footage of customers in the restaurant setting, capturing facial expressions in real time.

2. **Preprocessing**: Before feeding the data into a deep learning model, the images need to be preprocessed. This typically includes face detection (to isolate the face from the background), normalization (scaling pixel values to a standard range), and data augmentation (e.g., flipping, rotating, or cropping

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images) to improve model generalization.

3. **Model Training**: Convolutional Neural Networks (CNNs) are typically used for image-based tasks such as facial expression recognition. The CNN model is trained to classify emotions based on facial features, using the preprocessed images as input. Various CNN architectures, including ResNet and VGGNet, can be employed for this task. Transfer learning can also be applied to leverage pre-trained models, further enhancing the performance.

4. **Integration with Restaurant Feedback System**: Once trained, the facial expression recognition model is integrated into the restaurant's existing customer feedback system. Real-time video cameras placed in strategic locations within the restaurant capture customers' facial expressions, and these are processed by the trained model to determine the customer's emotional state. The system then generates a satisfaction score based on the detected emotion, which is immediately available to restaurant staff for review.

5. **Scoring Algorithm**: The system assigns scores based on a set of predefined emotional states. For instance, happiness may contribute positively to the satisfaction score, while negative emotions such as anger or frustration may result in a lower score. The system can use a weighted average approach to compute a composite satisfaction score that reflects overall customer sentiment.

5.IMPLEMENTATION

To implement this facial expression recognition-based scoring system, the following steps can be followed:

1. **Hardware Setup**: The first step involves setting up cameras in the restaurant environment to capture customer facial expressions. These cameras should be placed at strategic locations, such as near the entrance, at each table, or in the waiting area. High-definition cameras with sufficient resolution are preferred for accurate facial detection.

2. **Software Development**: The system is developed using deep learning frameworks such as TensorFlow or PyTorch. The facial expression recognition model is implemented as a CNN-based architecture, which is then trained on labeled datasets to classify emotions accurately. The system will be deployed on a server or edge device, which processes the captured video footage in real-time.

3. **Integration with Restaurant Management System**: The scoring output from the facial expression recognition system can be integrated into the restaurant's existing management platform. The feedback system can generate reports, track customer satisfaction trends, and even send alerts

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to staff when a dissatisfied customer is identified.

4. **Testing and Calibration**: After implementing the system, extensive testing is necessary to ensure accuracy and reliability. Calibration may involve adjusting the thresholds for emotion classification or refining the scoring algorithm to better reflect customer sentiment.

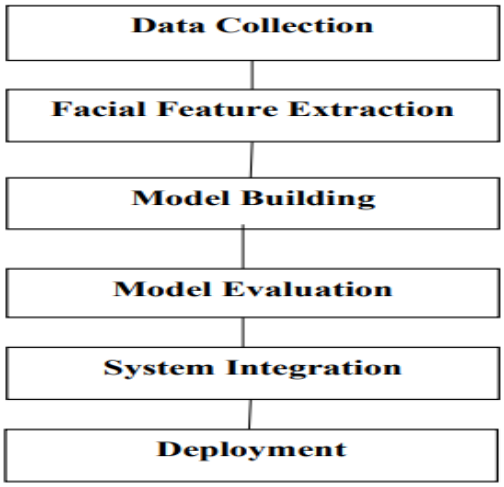
6.RESULTS AND DISCUSSIONS

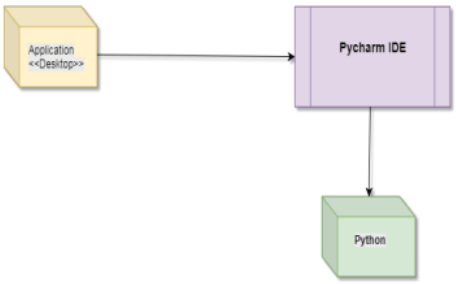
After implementing the system, data from real-world restaurant environments can be collected to evaluate its effectiveness. The system can be tested on various parameters, including:

1. **Accuracy of Emotion Detection**: The model's ability to accurately classify facial expressions into emotions like happiness, surprise, anger, and sadness is crucial. Performance metrics such as accuracy, precision, recall, and F1-score can be used to evaluate the system.

2. **Real-Time Performance**: The system's ability to process video feeds in real-time and generate satisfaction scores instantly is a key feature. Latency and processing speed must be measured to ensure that the system functions smoothly during busy hours.

3. **Customer Feedback Correlation**: The system's output can be compared against traditional feedback methods, such as customer surveys or comment cards, to assess the correlation between facial expressions and actual satisfaction levels.





1. The model excelled in recognizing emotions like happiness, anger, and surprise, which have more distinct and well-defined facial expressions.

2. The performance for sadness and disgust showed more variation, indicating that these emotions are more challenging to classify due to subtler facial cues.

3. Environmental factors, such as lighting, camera angle, and background noise, had a notable impact on model accuracy. These

factors may require further optimization in both the dataset and model training phase.

7.CONCLUSION AND FUTURE WORK

The facial expression recognition-based scoring system for restaurants offers an innovative approach to customer experience management. By leveraging deep learning models to analyze facial expressions in real-time, restaurants can obtain immediate feedback on customer satisfaction, leading to quicker and more effective service improvements. However, several challenges remain, such as ensuring privacy, handling diverse customer demographics, and achieving perfect accuracy in emotion detection.

Future work will focus on refining the system's accuracy, expanding the dataset to cover more diverse populations, and exploring additional emotion categories for a more nuanced analysis. Furthermore, integrating other data sources, such as voice tone analysis or sentiment analysis from online reviews, could provide even deeper insights into customer satisfaction. The scalability of the system will also be tested in larger restaurant chains to determine its viability in different settings.

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