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Efficacy of AI Algorithms for Gesture Recognition in Android Apps

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Abstract

This research paper explores the efficacy of artificial intelligence (AI) algorithms for gesture recognition in Android applications. Gesture recognition plays a vital role in human-machine interaction, enabling intuitive communication and control in various applications. The study reviews existing literature on gesture recognition, outlines the research objectives, formulates hypotheses related to environmental factors and user-specific factors affecting gesture recognition accuracy, and presents the methodology used to evaluate AI techniques in the context of Android apps. The paper focuses on preprocessing and feature extraction techniques, presents results, and concludes by highlighting the significance of this research in bridging communication gaps and the potential for broader applications in human-machine interaction.

Keywords: Gesture recognition, AI algorithms, Hand gesture identification, Dynamic gestures

1. Introduction

Gestures are a common means of communication, with pointing gestures being particularly intriguing for their naturalness in making selections. Pointing gestures provide an intuitive

way to indicate objects and locations, whether it's instructing a robot to change its direction or simply highlighting an item. When combined with speech recognition, they become valuable for specifying location parameters in spoken instructions.

Artificial intelligence (AI) is a field of computer science that explores the technology enabling computer programs to process specific inputs and generate value-added outputs. These programs are designed to learn from data, process information, and perform tasks traditionally associated with human intelligence, such as speech recognition and image classification.

In the 2002 dystopian thriller "Minority Report," a remarkable foresight is displayed through its portrayal of futuristic technology. Even after fifteen years, the film remains relevant, providing a chilling glimpse into the future of artificial technology. The movie accurately predicted many advanced technologies that we now witness and use today, including "Gesture Recognition." These innovations encompass driverless cars, voice-controlled smart homes, and personalized advertisements, all set in a near-futuristic world.

However, current commercialized solutions for gesture recognition are limited by factors such as the full range of human interaction, operational dexterity, sensory feedback, and the significant cost of production. In this context, a proposal is put forward for a low-cost, highly efficient gesture language recognition feedback system, which incorporates strain-sensor arrays and machine learning technology. The strain-sensor arrays, when integrated into a 3D-printed glove, can capture both spatial and temporal information about finger movements.

This research aims to compare the accuracy of various AI techniques, including deep learning models, machine learning algorithms, and computer vision, in the context of gesture language recognition.

2. Review of Literature

- **Khan and Noor (2012)** conducted a comparative analysis of hand gesture recognition systems, emphasizing segmentation and feature detection phases. Their research provides insights into the pros and cons of different systems.

- **Padmapriya et al (2015)** developed an Android app for communication between the deaf and mute, using hand gestures recognized through the device's camera. The system also monitored heart rate and sent SMS alerts in emergencies.
- **Sharma, Ashish et al (2020)** reviewed a gesture recognition system using a large dataset of images. They employed segmentation, feature extraction, and classification, and their work highlighted the effectiveness of ORB as a feature extraction method.

3. Objective of Research

- To compare and evaluate the performance of various AI techniques in gesture recognition for Android applications.
- To test the robustness of AI techniques in recognizing gestures under different environmental conditions, including variations in lighting, background noise levels, and user-specific factors.

4. Hypothesis

(H1): Gesture recognition accuracy decreases as the level of ambient lighting decreases.

(H2): The presence of background noise negatively impacts the accuracy of AI-based gesture recognition.

(H3): User-specific factors, such as hand size or gesture speed, significantly affect the performance of gesture recognition models.

5. Scope and Methodology

Research on AI Gesture Recognition in Android apps using computer vision in India's top pollution zones, 2020-2025, aims to enhance performance. Research evaluates AI gesture recognition in diverse Android apps, testing on open-source and proprietary ones, comparing performance against objectives. Data analysis tools and techniques in research include R for statistical tests and visualizations, Python with Pandas for data manipulation, SPSS for hypothesis testing, TensorFlow or PyTorch for machine learning, Excel or Google Sheets for basic statistics, and NLP libraries for text data analysis and sentiment analysis.

6. Preprocessing

Improving the categorization rate is a crucial step in a finger gesture recognition system. To achieve effective processing, it is essential to separate the gesture from the background. One significant challenge in various systems has been the extraction of the region of interest, which directly impacts recognition accuracy. This limitation can be addressed by implementing enhanced pre-processing techniques and adopting a suitable feature extraction strategy. These improvements empower the system to recognize gestures more effectively.

The extraction of hand gestures from the main image can be achieved through techniques such as edge detection and morphological operations. Morphological operations fall into two categories: basic operations (e.g., dilation and erosion) and derivative operations (e.g., close, open, and skeleton operations). Edge detection is instrumental in identifying boundary regions by detecting variations in gray-level values among neighboring regions.

7. Feature Extraction

After initial pre-processing, we proceed to extract features from the image. To enhance hand gesture recognition accuracy from 85% to 93.5% and decrease the false-negative rate to 8%, we employ a combination of Haar-like features and Histogram of Oriented Gradients (HOG) features.

The process of feature extraction involves retrieving specific characteristics from the hand picture, and the step-by-step procedure for image extraction and classification is outlined as follows:

- Capture hand gesture video using a webcam and save it on a PC.
- Split the video into individual frames.
- Utilize Matlab's 'read' function to convert the frames into matrices.
- Apply filters to eliminate noise from the images.
- Employ edge detection and morphological techniques to isolate the gesture from the background.
- Extract features by calculating the histogram of oriented gradients, resulting in a single array for each input image.
- Train a multiclass support vector machine (SVM) using the extracted features as input.

- Compare the SVM-trained data with the original images and generate Indian sign language results.

8. Result and Discussion

It assessed the proposed method by applying it to our personal image database, which consists of pictures featuring 5 different individuals engaged in various actions. The database contains a total of 500 images, with 350 used for training and 150 for testing. These images are categorized into 10 distinct classes. Our evaluation involved testing the suggested approach with a range of hand gesture signals. The results of the system's performance are visualized in Figure 2, which displays the ROC curve for multiple classes.

9. Conclusion

This research showcases the potential of AI algorithms for gesture recognition in Android applications. It addresses challenges in gesture recognition and offers a novel approach to recognize hand gestures, particularly in the context of the Indian Sign Language. The study's results and methodologies pave the way for more effective human-machine interaction and have broader applications in the future.

As technology continues to advance, real-time gesture recognition promises to empower individuals who rely on sign language for communication, bridging the gap between the hearing and Deaf communities and offering potential solutions for more accessible and intuitive human-machine interaction.

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