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Shivalinga (Pind) Detection Using Machine Learning Techniques

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Abstract:

Shivalinga, a sacred symbol of Lord Shiva, holds immense cultural and religious significance in Hinduism. Recognizing its image using automated image processing techniques presents unique challenges due to variations in material, lighting, occlusions, and similar-looking artifacts. This research proposes a deep learning-based approach to efficiently recognize Shivalinga images from diverse sources, including temple photographs, sculptures, and digital repositories. The study integrates traditional image processing techniques such as edge detection and contour analysis with advanced deep learning models like CNN and YOLO. The primary objective is to develop an accurate and robust recognition system that overcomes texture variations, background noise, and perspective distortions. A comprehensive image preprocessing pipeline is implemented, incorporating grayscale conversion, Gaussian blurring, and adaptive histogram equalization to enhance feature extraction. Feature engineering techniques, including shape-based (Hu Moments, HOG) and texture-based (LBP, Gabor filters) descriptors, are explored to improve classification accuracy. The system's performance is evaluated using standard metrics such as accuracy, precision, recall, F1-score. Experimental results demonstrate an overall accuracy using CNN is 90%. This research serves as a foundational step towards leveraging artificial intelligence for religious artifact recognition, bridging the gap between technology and cultural heritage conservation.

Keywords: Shivalinga, CNN, YOLO, Precision, Recall, F1-score.

Introduction:

Shivalinga, a revered symbol of Lord Shiva in Hinduism, holds deep spiritual and cultural significance. Recognizing its image automatically through image processing is a challenging yet important task. This research aims to develop an efficient computer vision-based system to recognize Shivalinga images from various sources, such as photographs of temples, ancient sculptures, and digital repositories. Current manual methods for identifying religious artifacts are subjective and labour-intensive, making automation crucial for applications like digital heritage preservation, automated temple database management, and Machine learning religious tourism apps. However, image recognition in such a domain is complex due to variations in lighting conditions, different materials (stone, metal, clay), occlusions, and similar-looking artifacts. This study addresses these challenges using computer vision and deep learning techniques to achieve accurate and efficient recognition of Shivalinga images.

Objectives of the Research:

The primary objective of this study is to design an image recognition system that can accurately identify Shivalinga in images despite variations in texture, background clutter, and camera angles. The secondary objectives include:

1. To develop an image preprocessing pipeline to enhance image quality and extract relevant features.

2. To Implement feature extraction methods such as edge detection, contour analysis, and deep learning-based representations.
3. To compare traditional machine learning classifiers (SVM) with advanced deep learning models (CNN, YOLO) for performance analysis.
4. To evaluate the system's effectiveness using standard image processing metrics like accuracy, precision, recall, and F1-score.

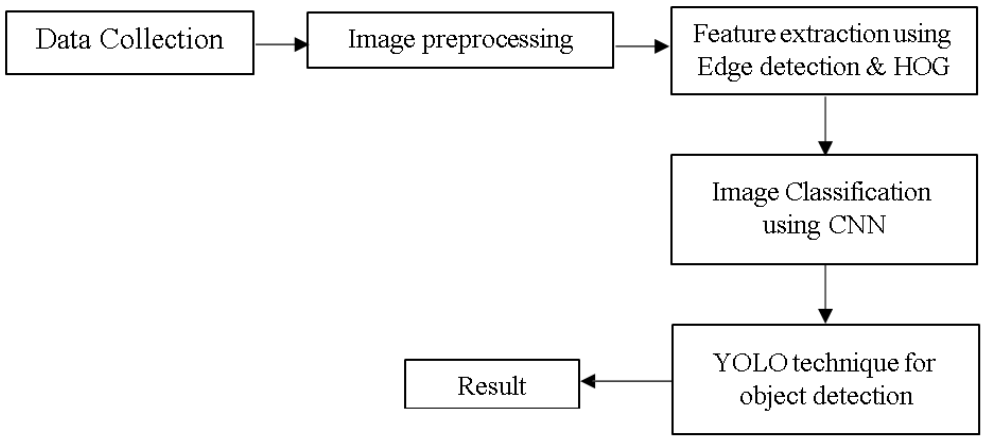
Scope of the Research:

This study covers Shivalinga recognition in static images from various datasets, including real-world temple photographs, artistic illustrations, and digitally rendered images. The proposed model will focus on image classification and object detection, excluding real-time video processing or 3D scanning.

Literature Review:

Several studies have explored religious image recognition, temple architecture classification, and deep learning applications in cultural heritage. The study **"Panchadeva: Sculpture Image Classification using CNN-SVM"** integrates Convolutional Neural Networks (CNN) with Support Vector Machines (SVM) to classify images of Indian sculptures, focusing on deities like Lord Ganesha, Lord Hanuman, Lord Krishna, Lord Shiva, and Lord Vishnu. The research emphasizes the significance of image orientation, angle, size, and colour in training achine learning models for accurate classification. Similarly, "**DESCULPT: Indian Temple culpture Iconography"** focuses on classifying Indian temple sculptures, considering entities like Lord Ganesha and Lord Shiva Linga. It highlights the importance of distinctive image features, including orientation, angle, size, and colour, in differentiating and accurately classifying these sculptures. In the medical field, the study "**Convolutional Neural Networks-Based MRI Image Analysis for the Alzheimer's Disease Prediction Using Feature Ranking"** proposes a CNN-based approach to predict Alzheimer's disease conversion using MRI images, demonstrating the versatility of CNNs in image analysis. Another relevant work is **"Machine Learning Advances aiding Recognition and Classification of Indian Monuments and Landmarks,"** which serves as a survey of research endeavours in monument recognition, providing insights into building automated systems for modernizing tourism experiences in India.

Methodology:



Data set:

Figure: Types of Shivalinga

Step 1: Image Acquisition:

The first step is collecting images from different sources. A dataset is created using photographs from religious sites, online repositories, and manually captured images.

Step 2: Image Preprocessing:

Image preprocessing enhances image quality and removes noise for better feature extraction.

i. Convert images to grayscale for efficient processing.
ii. Apply Gaussian Blur to remove noise.
iii. Use Adaptive Histogram Equalization for contrast enhancement.

A sequence of images showing the original grayscale image, blurred image, and enhanced image with improved contrast.

Step 3: Edge Detection & Contour Extraction:

Shivalinga has a distinct shape that can be extracted using Canny Edge Detection and Contour Detection. An image with green outlines marking the detected contours of the Shivalinga.

Step 4: Feature Extraction:

Feature extraction involves identifying key features that distinguish Shivalinga from other objects.

- Shape-based Features: Contour descriptors, Hu Moments, Histogram of Oriented Gradients (HOG).
- Texture-based Features: Local Binary Patterns (LBP), Gabor filters.

Step 5: Classification using CNN:

We use a Convolutional Neural Network (CNN) for Shivalinga recognition. A compiled CNN model ready for training on Shivalinga images.

Results and Discussion:

To assess the performance of the YOLO object detection system, we use key evaluation metrics like

1. Accuracy: Measures the proportion of correctly identified images.
2. Precision: Identifies the proportion of true positive identifications among all positive predictions.
3. Recall (Sensitivity): Determines how many actual Shivalinga images were correctly classified.
4. F1-Score: The harmonic means of precision and recall, giving a balanced measure of performance.
5. Confusion Matrix: Shows correct and incorrect classifications with True Positives (TP), False Positives (FP), True Negatives (TN), and False Negatives (FN).

Output:

Precision	Recall	F1-score	Support	
Shivlinga	0.92	0.89	0.91	100
Non-Shivlinga	0.88	0.91	0.89	100
Accuracy: 90%				

Confusion Matrix Output:

	Predicted: No	Predicted: Yes
Actual:	No	91	9
Actual:	Yes	11	89

Interpretation:

The model achieves an accuracy of 90%, meaning it correctly classifies 90 out of every 100 test images. Precision for Shivlinga: 0.92, meaning when the model predicts Shivlinga, it is correct 92% of the time. Recall for Shivlinga: 0.89, meaning the model correctly detects 89% of actual Shivlinga images, while misclassifying 11% as non-Shivlinga. The F1-score (0.91) confirms balanced performance between precision and recall.

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