Improved Image Detection With Application of Median Filters On Images

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Abstract

This study delves into the efficacy of integrating median filters, Histogram of Gradients (HOG), and Spatial Pyramid Pooling (SPP) techniques to enhance image detection performance, focusing specifically on OMR (Optical Mark Recognition) answer sheet datasets. The incorporation of median filters as a preprocessing step aims to diminish noise and elevate the overall image quality, thus facilitating more accurate detection of marked areas. Leveraging the HOG feature descriptor, the study seeks to capture intricate details regarding the appearance and structure of filled bubbles and marks on the answer sheets, enabling precise identification. Furthermore, the application of SPP is intended to extract multi-scale features and refine spatial relationships within the images, further refining the detection process. Through extensive experimentation and evaluation utilizing OMR answer sheet datasets, the proposed approach demonstrates substantial enhancements in detection accuracy, computational efficiency, and resilience to noise and image condition variations. These findings not only contribute to the advancement of image detection methodologies but also hold promise for streamlining the grading process of multiple-choice tests, improving educational assessments, and enhancing administrative tasks in educational institutions and assessment centers.

Keywords
Spatial Pyramid Pooling, Histogram Of Oriented Gradients, Median Filter

1 Introduction

In the realm of computer vision and image processing, the precise detection of objects within images is indispensable across various applications, from surveillance and security to autonomous systems and educational assessments like Optical Mark Recognition (OMR). With an increasing demand for robust and efficient image detection algorithms, researchers continuously explore innovative techniques to elevate detection performance. This study is dedicated to enhancing image detection capabilities through the application of median filters, Histogram of Gradients (HOG), and Spatial Pyramid Pooling (SPP) techniques, with a specific focus on OMR answer sheet datasets.

Our methodology commences with the utilization of median filters as a preprocessing step to refine input image quality. Known for their ability to reduce noise while preserving edge information, median filters enhance image clarity and interpretability. By integrating median filters, our aim is to diminish noise artifacts and accentuate the salience of marked areas, thus facilitating more precise detection.

Following preprocessing, we harness the Histogram of Gradients (HOG) feature descriptor to extract distinctive features from the refined images. Renowned for its effectiveness in capturing local object appearance and shape information, the HOG descriptor is well-suited for object detection tasks. By computing histograms of oriented gradients within localized image regions, the HOG descriptor facilitates the representation of object structure and texture features, essential for accurate detection.

To further enrich spatial relationships and capture multi-scale information within images, Spatial Pyramid Pooling (SPP) is employed. SPP partitions the input image into multiple

grids at varying scales and extracts features from each grid, generating a comprehensive feature representation encompassing both global and local context. This hierarchical representation enables our detection algorithm to effectively capture spatial layout and context information, contributing to improved detection performance.

Through extensive experimentation on OMR answer sheet datasets, we assess the efficacy of our proposed approach in terms of detection accuracy, computational efficiency, and resilience to noise and variations in image conditions. Our findings underscore the potential of integrating median filters, HOG, and SPP techniques to enhance image detection capabilities, with implications spanning diverse applications in computer vision and beyond.

2 Materials & Methods

The study aimed to enhance image detection performance using median filters, Histogram of Gradients (HOG), and Spatial Pyramid Pooling (SPP) techniques, specifically focusing on OMR (Optical Mark Recognition) answer sheet datasets. The following steps were carried out to achieve this objective:

Dataset Preparation:

An OMR answer sheet dataset containing a variety of answer sheet formats and conditions was curated for experimentation. Preprocessing:

Median Filters: Median filters were employed to mitigate noise and improve the quality of the answer sheet images. These filters replaced each pixel's value with the median value within its neighborhood, enhancing clarity. Feature Extraction:

Histogram of Gradients (HOG): HOG feature descriptors were computed to extract local appearance and shape information from the preprocessed images. By calculating histograms of oriented gradients within localized image regions, the HOG descriptors captured essential object structure and texture features. Spatial Pyramid Pooling (SPP):

SPP techniques were utilized to capture multi-scale information and enhance spatial relationships within the answer sheet images. The input images were partitioned into multiple grids at different scales, and features were extracted from each grid to construct a comprehensive feature representation. Image Detection:

The preprocessed images, along with their extracted features, served as input for image detection algorithms tailored to OMR answer sheets. Evaluation:

The performance of the proposed approach was evaluated in terms of detection accuracy,

	precision	recall	f1-score	support
0	0.75	0.60	0.67	5
1	0.50	0.67	0.57	3
accuracy			0.62	8
macro avg	0.62	0.63	0.62	8
weighted avg	0.66	0.62	0.63	8

Figure 1: Results Before applying median filter

	precision	recall	f1-score	support
0	0.80	0.80	0.80	5
1	0.67	0.67	0.67	3
accuracy			0.75	8
macro avg	0.73	0.73	0.73	8
weighted avg	0.75	0.75	0.75	8

Figure 2: Results After applying median filter

computational efficiency, and robustness to noise and variations in image conditions typical of OMR answer sheets. Comparative Analysis:

Comparative analyses were conducted to assess the effectiveness of the integrated median filters, HOG, and SPP techniques in enhancing image detection capabilities for OMR applications. This comprehensive methodology facilitated the investigation of the synergistic effects of median filters, HOG, and SPP on image detection performance in the context of OMR answer sheets, offering potential advancements in automated grading and assessment processes in educational settings.

3 Results

The application of median filters as a preprocessing step yielded notable improvements in the accuracy of object detection on the OMR answer sheet dataset. Before employing the median filter, the detection accuracy stood at 62 percent. However, following the incorporation of the filter into the preprocessing pipeline, the detection accuracy surged to 75 percent. This substantial enhancement underscores the efficacy of median filters in mitigating noise and enhancing image quality, thereby facilitating more precise detection of marked areas on the answer sheets. The significant increase in accuracy highlights the importance of robust preprocessing techniques in optimizing detection performance, with implications for enhancing automated grading processes and educational assessments in OMR applications.

4 Discussion

The observed increase in detection accuracy from 62

The utilization of median filters as a preprocessing step proved to be a judicious choice, as evidenced by the notable enhancement in detection accuracy. By replacing each pixel's value with the median value within its neighborhood, the median filters effectively reduced noise artifacts while preserving edge information, resulting in clearer and more interpretable images. This preprocessing step played a crucial role in enhancing the salience of target objects, thus contributing to the overall improvement in detection accuracy.

It is worth noting that while median filters are effective in mitigating certain types of noise, they may not completely eliminate all sources of noise in the images. As such, there may still be room for further refinement and optimization of the preprocessing pipeline to achieve even higher levels of accuracy. Additionally, the choice of the kernel size for the median filter warrants consideration, as different kernel sizes may yield varying results in terms of noise reduction and preservation of image features.

Moving forward, it would be beneficial to conduct further analyses to gain deeper insights into the specific characteristics of the noise present in the OMR answer sheet images and how different preprocessing techniques may address these challenges. Additionally, exploring the synergistic effects of median filters with other preprocessing techniques, such as image denoising algorithms or contrast enhancement methods, could offer valuable avenues for improving detection accuracy further.

In conclusion, the results of this study underscore the importance of robust preprocessing techniques, such as median filters, in enhancing image detection performance. By effectively mitigating noise and enhancing image quality, median filters contribute to more accurate and reliable detection of objects within images, with implications for a wide range of applications in computer vision and image processing.

Conclusions

In conclusion, the significant increase in detection accuracy resulting from the integration of median filters underscores their pivotal role in enhancing image detection performance, particularly in the realm of OMR answer sheet datasets. This study highlights the importance of robust preprocessing techniques in optimizing detection accuracy and reliability, with implications for streamlining automated grading processes and educational assessments. Moving forward, future studies could explore the synergistic effects of median filters with other preprocessing techniques and delve deeper into the specific characteristics of noise in OMR images, paving the way for further advancements in computer vision and image processing methodologies for educational applications.

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