

Image Processing for Clean vs. Dirty Floor Identification

This document presents the proposed solution for the task of distinguishing between clean and dirty floors using YOLOv5, an advanced object detection framework. The approach is compared to traditional image processing methods, highlighting the benefits of deep learning for this classification problem.

Why YOLO is the Best Choice?

Feature	YOLOv5	Other Methods
Accuracy	High	Varies
Speed	Real-time detection	Slower
Scalability	Supports large datasets	Limited for traditional CV
Ease of Integration	Pretrained weights available	Requires custom development

YOLOv5 is chosen because:

- It offers real-time detection, which is essential for dynamic environments.
- Pretrained weights allow faster prototyping and deployment.
- It excels in tasks with complex datasets, handling multiple object categories efficiently.

1. Dataset Acquisition

- A dataset comprising images of floors was collected with diversity in lighting, dirt types, and floor textures.
- Images were annotated into five categories: 0 (very dirty) to 4 (very clean) using tools like LabelImg.
- Example images include variations like day-night lighting and different floor types (tiles, footpaths).

2. Preprocessing

- Standardized image sizes (640x640) for YOLOv5 compatibility.
- Applied normalization, denoising, and sharpening for better feature extraction.

3. Feature Extraction

- YOLOv5 automatically extracts texture, color gradients, and patterns to distinguish floor cleanliness levels.
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4. Model Development

- YOLOv5 model was trained with an 80-20 split for training and testing data.
- Data augmentation was used for robustness, and hyperparameters were optimized to improve accuracy.

5. Evaluation

- Model was evaluated using precision, recall, F1-score, and confusion matrix.
- Accuracy was compared across categories (0 to 4), ensuring effective classification of cleanliness levels.

6. Cleanliness Rating (0-4 Stars)

- Defined categories:
 - 0: Very dirty
 - 4: Very clean
- YOLOv5 predictions were post-processed to assign cleanliness ratings.
- Results were saved as annotated output images with ratings.

7. Comparison: Traditional vs. YOLOv5 Approach

Traditional Approach:

- Relied on handcrafted features like color histograms, edge detection, and texture analysis.
- Performance heavily depended on predefined thresholds and parameters.
- Limited scalability for diverse conditions (e.g., varying lighting, floor types).

YOLOv5 Approach:

- Learns features directly from data, adapting to diverse scenarios.
- High accuracy and scalability due to deep learning.
- Robust to variations in lighting and floor textures.
- Faster predictions and real-time inference capabilities.

Outcome: The YOLOv5 approach outperforms traditional methods in accuracy, robustness, and real-world adaptability.

8. Future Improvements

- Explore YOLOv8 or other advanced models for further accuracy improvements.
- Deploy as a real-time application for practical use cases.
- Handle edge cases with mixed cleanliness levels in a single frame.

9. Conclusion

This solution leverages YOLOv5 to effectively classify and rate floor cleanliness levels. It demonstrates the superiority of modern deep learning techniques over traditional approaches, ensuring scalability and robustness for real-world applications.

10. Links

- Code Repository: <https://github.com/arssite/Dirty-CleanFlooringImageProcessingUsingYolov5>
- ReadMe:
<https://github.com/arssite/Dirty-CleanFlooringImageProcessingUsingYolov5/blob/main/README.md>
- Dataset:
<https://github.com/arssite/Dirty-CleanFlooringImageProcessingUsingYolov5/releases/tag/Dataset>
- Annotated Output :
<https://github.com/arssite/Dirty-CleanFlooringImageProcessingUsingYolov5/blob/main/Annotated%20Output.zip>
- References :
<https://www.nature.com/articles/s41598-023-38538-3.pdf>
<file:///C:/Users/hp/Downloads/ADeepLearningApproachforClassificationofCleanlinessinRestrooms.pdf>
https://www.researchgate.net/publication/356691001_A_Deep_Learning-Based_Dirt_Detection_Computer_Vision_System_for_Floor-Cleaning_Robots_with_Improved_Data_Collection