PROJECT ABSTRACT

Parking Lot Occupancy Detection using Computer Vision

A CNN bay-classifier trained on the PKLot dataset (12,417 images, ~696,000 segmented spaces) that marks every parking bay occupied or empty from overhead cameras, with a live dashboard showing zone analytics and guidance-ready tallies.

Project type: Software

Availability: Built to order

Suitable branches: AI & Machine Learning

Technologies: Python 3, TensorFlow/Keras, OpenCV, PKLot dataset, ONNX Runtime, NumPy, HTML dashboard

Price: Request a quotation

Prepared by Projectech · projectech.in — for academic project reference.

1. Title

Parking Lot Occupancy Detection using Computer Vision — real-time bay-level availability from the cameras already on the poles.

2. Introduction and Background

Drivers circling for parking waste fuel and time while lot operators have no real-time picture of free bays. Per-bay sensor hardware exists but is costly to install and maintain at scale. Overhead cameras, already common in lots, can provide the same information with software: a binary classifier applied to each marked bay crop. The public PKLot dataset (12,417 images, ~696,000 segmented spaces across three lots and varied weather) provides the training and evaluation foundation, including the cross-lot generalization test that makes this project academically honest.

3. Problem Statement

Parking operators and drivers need accurate, real-time, bay-level occupancy without expensive per-bay hardware. A vision system is needed that works from overhead camera frames, adapts to a new lot with a one-time bay-marking step, stays accurate across weather conditions, and feeds both an operator dashboard and driver-guidance signage.

4. Objectives

- Train a binary CNN classifier on PKLot segmented bay crops (occupied/empty).
- Provide a one-time bay-marking tool storing polygons as reusable JSON.
- Aggregate per-bay results into zone tallies and lot-wide occupancy in real time.
- Build a dashboard with bay overlays, zone bars, hourly trends and dwell-time analytics.
- Validate cross-lot generalization (train on two lots, test on the third).

5. Proposed Methodology

The operator marks bay polygons once per camera view. Each frame is optionally stabilized, every bay polygon is cropped, resized to 128×128 and normalized, then classified by a custom CNN (conv blocks 32→64→128, global average pooling, dense-128, dropout 0.4, sigmoid output). Per-bay results aggregate into zone tallies and lot occupancy; tallies are formatted for guidance signage. Training uses all three PKLot lots and weather subsets; evaluation reports bay accuracy, cross-lot accuracy and per-condition breakdowns (sunny/cloudy/rainy).

6. System Architecture and Working

Four stages. **Marking:** one-time bay polygons per camera, saved as JSON. **Classification:** bay crops scored occupied/empty with confidence each frame. **Aggregation:** zone tallies, occupancy donut data and dwell-time histories updated live. **Presentation:** a single-file HTML dashboard renders the overhead view with per-bay overlays, the occupancy donut, zone bars, hourly trends and lane statistics, plus a signage-ready tally feed. ONNX export allows pole-side scoring.

7. Hardware and Software Requirements

- Laptop or desktop (CPU inference ~1.2 s per 120-bay lot; GPU faster).
- Python 3.10+, TensorFlow/Keras, OpenCV, NumPy, Matplotlib.
- PKLot dataset (public, UFPR) for training.
- Overhead parking-lot camera or sample lot footage.
- Modern web browser for the dashboard.

8. Expected Outcomes

A bay classifier at 99.1% bay accuracy and 96.8% cross-lot accuracy (design targets), with rain/night degradation under 2.5 percentage points. Targets are for the built-to-order training run; the report documents achieved figures per condition. Deliverables: trained model, marking tool, aggregation pipeline, dashboard, evaluation analysis, report, PPT, viva Q&A.;

9. Applications

- Mall, airport and office parking guidance with live availability.
- Operator dashboards for lot utilization analytics and pricing decisions.
- Smart-city parking information feeds.
- Teaching binary classification, geometric pre-processing and applied analytics.

10. Future Scope

- License-plate-linked bay reservations and billing integration.
- Automatic bay detection to remove manual marking.
- Multi-camera lot stitching for very large facilities.
- Demand prediction from historical occupancy patterns.