MANIPAL UNIVERSITY

School of Computer Science and Engineering
Department of Computer Science and Engineering

SMART PARKING SYSTEM USING CCTV

Aakshi Mahajan
2427030740

Supervised By:
SURBHI SAYAL

INTRODUCTION

Problem Identification:

Growing vehicle numbers cause parking congestion, time wastage, and inefficient space usage in urban areas

Proposed Solution

A smart parking system that uses CCTV cameras and machine learning to detect available parking spots automatically.

Technology Used

Machine learning and computer vision analyze video feeds to identify empty and occupied spaces without extra sensors.

Benefits

The system improves parking efficiency, reduces congestion, saves time, and provides a cost-effective, scalable solution for smart cities.

Literature Overview

Topics Covered

1. Traditional Parking Systems
2. Vision-Based Parking Systems
3. Machine Learning & Deep Learning Approaches
4. Cloud & IoT Integration
5. Key Insight

LITERARTURE OVERVIREW

Traditional Parking Systems

- Early systems relied on ultrasonic, infrared, or RFID sensors to detect vehicles.
- These systems transmitted data to a central unit for slot availability updates.
- Effective in small or enclosed areas but limited in scalability for large cities.
- High installation and maintenance costs reduce overall practicality. (Almulla & Al-Mulla, 2018)

Vision Based Parking Systems

- Utilizes CCTV cameras and computer vision for parking space monitoring.
- Employs techniques like object detection, image segmentation, and background subtraction.
- Detects vehicle presence in real time without physical sensors.
- More cost-effective by using existing surveillance infrastructure. (Hsieh et al., 2020)

LITERARTURE OVERVIREW

Machine Learning & Deep Learning Approaches

- Integration of Machine Learning (ML) and Deep Learning (DL) enhances detection accuracy.
- CNN-based models (e.g., YOLO, Faster R-CNN) classify vehicles and parking slot status.
- Performs effectively under varied lighting and weather conditions.
- Enables real-time processing of live video feeds for dynamic parking updates.(Amato et al., 2017; Ullah et al., 2021)

Cloud & IoT Integration

- Parking data can be uploaded to cloud platforms for remote access.
- Mobile applications provide real-time parking slot information to users.
- IoT devices help automate entry, exit, and payment processes.
- Results in reduced congestion and better urban mobility management.(Lin et al., 2019)

Literature Survey

Name	Abstract (Summary)	Technology / Method Used	Result	Future Scope
Almulla & Al-Mulla (2018)	Smart parking system using WSN sensors for slot occupancy detection.	Ultrasonic / IR Sensors, WSN	Accurate for small areas	Improve scalability; cloud integration
Hsieh, Chen & Lin (2020)	Vision-based parking monitoring using CCTV + CV algorithms.	Background subtraction, segmentation, CV	Real-time detection without sensors	Improve accuracy with DL; multi-camera fusion
Amato, Carrara & Falchi (2017)	CNN-based vehicle detection for parking occupancy.	CNN Models	High accuracy under varied lighting	Use YOLO for real-time performance
Lin, Liu & Xu (2019)	IoT + Cloud smart parking framework with automation.	IoT, Cloud Computing	Remote access and monitoring	Add ML prediction; smart city linkage
Ullah, Shah & Yu (2021)	Deep CNN-based real-time vehicle detection system.	Deep CNN Models	High real-time detection accuracy	Apply to parking classification; edge optimization

Problem Statement

Increasing vehicles cause parking issues, congestion, and pollution. Current systems are costly and inefficient. A CCTV- and ML-based smart parking system is needed for real-time, automated management.

Proposed Solution

Our proposed Smart Parking System uses CCTV cameras and Machine Learning to automatically detect parking slot occupancy in real time. The system works as follows:

- Data Collection: CCTV cameras capture live video feeds of the parking area.
- Preprocessing: Videos are processed to extract frames, enhance image quality, and detect parking slot boundaries.
- Vehicle Detection: Computer Vision and Deep Learning (CNN models) are used to identify vehicles in each parking slot.
- Slot Status Classification: Each parking slot is classified as occupied or vacant using trained ML models.
- User Interface & Notification: Available slots are displayed to users via a mobile/web app, helping them locate free parking quickly.

Technologies Used

- Machine Learning / Deep Learning: CNN models (YOLO, Faster R-CNN) for vehicle detection.
- Computer Vision: OpenCV for image processing and frame extraction.
- CCTV / Video Surveillance: Existing camera infrastructure for monitoring.
- Software / Tools: Python, TensorFlow or PyTorch, Flask/Django for web interface.
- Database & Cloud: SQL/NoSQL database for storing parking data; optional cloud integration for scalability.

Outcome

- Real-time parking slot detection.
- Reduced traffic congestion and time spent searching for parking.
- Cost-effective and scalable solution using existing infrastructure.

Research Progress on CNN Models

A CNN is a deep learning model that identifies patterns in images, making it ideal for tasks like object and vehicle detection

CNN Models Explored

- YOLO (v3/v5/v8): Researched for real-time vehicle and slot detection due to single-shot prediction.
- Faster R-CNN: Studied for high-accuracy detection using Region Proposal Networks.
- SSD (Single Shot Detector): Reviewed as a balanced model for speed and accuracy in parking environments.

Key Findings

- YOLO models provide the best real-time performance, making them suitable for live CCTV feeds.
- Faster R-CNN offers higher precision, useful for crowded or complex parking lots.
- SSD works well for medium-sized parking areas, giving consistent detection across lighting variations.

Current Status

- Literature survey completed for YOLO, Faster R-CNN, and SSD.
- Model comparison performed based on speed, accuracy, and suitability for CCTV systems.
- Dataset collection and preprocessing stage initiated for upcoming implementation

CCTV Usage & Integration with Deep Learning

How CCTV Is Used

- Captures continuous live video of parking areas.
- Provides wide coverage using existing infrastructure.
- How It Integrates With Deep Learning
- Frames extracted from CCTV video are preprocessed (resize, enhance).
- DL models (YOLO, Faster R-CNN, SSD) detect vehicles in each frame.
- Slot occupancy is identified by checking if a detected car overlaps a mapped slot.

Simple Workflow

- CCTV → Frame Processing → Deep Learning Detection → Slot Status → Display to Users

Benefits

- Real-time, accurate detection.
- No physical sensors needed.
- Scalable for large parking areas.

Why CCTV Is Better Than Sensors

Uses Existing Infrastructure

- Most buildings already have CCTV installed.
- No need for new hardware → reduces cost.

AdCovers Large Areas

- A single CCTV camera can monitor multiple parking slots.
- Sensors require one device per slot, increasing cost and maintenance.

Supports Deep Learning

- CCTV provides visual data needed for ML models (YOLO, CNNs).
- Sensors can only detect presence, not vehicle type or behavior.

More Accurate & Informative

- Detects vehicle shape, size, orientation, and movement.
- Sensors cannot differentiate between objects or classify vehicles.

References

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Thank you!