SMART PARKING

A PROJECT REPORT 18CSC305J

ARTIFICIAL INTELLIGENCE

Submitted by

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BONAFIDE CERTIFICATE

Certified that Mini project report titled **"SMART PARKING"** is the bona fide work of **AKSHAT JAIN [RA2111026010404], KRISHNA SHRIVASTAVA [RA2111026010399] and GRACY ARORA [RA2111026010390]** who carried out the minor project under my supervision. Certified further, that to the best of my knowledge, the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

This project presents the development and implementation of a smart parking system, integrating the YOLOv8 model pretrained for object detection, coupled with Python programming. The system aims to optimize parking space utilization and dynamically allocate prices for occupied spots. Leveraging YOLOv8's robust object detection capabilities, the system accurately identifies available parking spots in real-time, enhancing user convenience and reducing congestion. Additionally, Python programming is utilized to analyze data and determine optimal pricing strategies based on various factors such as demand and location. This paper details the design, implementation, and evaluation of the SMART PARKING SYSTEM, demonstrating its effectiveness in revolutionizing urban parking management.

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INTRODUCTION

The proliferation of vehicles in urban areas necessitates innovative solutions for efficient parking space management. Traditional methods often fall short in providing real-time information and dynamic pricing, leading to underutilization of parking spaces and frustration among users. To address these challenges, we introduce the SMART PARKING SYSTEM, a novel approach integrating the YOLOv8 model pretrained for object detection with Python programming.

The SMART PARKING SYSTEM employs YOLOv8's advanced object detection capabilities to accurately detect and classify available parking spots in real-time. By utilizing pre-trained weights, the system can swiftly identify vacant spaces, providing users with up-to-date information via a user-friendly interface. This enhances user experience by reducing the time spent searching for parking and minimizing traffic congestion.

In addition to real-time spot detection, Python programming is utilized to analyze various factors such as demand patterns, time of day, and location data to dynamically allocate prices for occupied parking spots. By leveraging Python's flexibility and data processing capabilities, the system optimizes pricing strategies to balance revenue generation for parking facility operators and affordability for users.

In summary, the SMART PARKING SYSTEM represents a significant advancement in urban parking management, combining state-of-the-art object detection technology with Python programming to enhance space utilization and user satisfaction. This paper will delve into the design, implementation, and evaluation of the system, highlighting its potential to transform the landscape of urban parking management.

LITERATURE SURVEY

Smith et al. (2018): "Object Detection in Parking Spaces Using YOLO" This study focused on the application of the You Only Look Once (YOLO) algorithm for real-time object detection in parking lots. The authors developed a system capable of identifying vacant parking spaces through the efficient and accurate detection capabilities of YOLO.

Johnson and Patel (2019): "YOLO-Based Parking Management System: A Case Study" Johnson and Patel explored the practical implementation of YOLO in a parking management ISSN 0971-3034 Volume,12Issue,1Mar, 2024 system. Their work delved into the integration of YOLO with automated control mechanisms for optimizing parking space allocation and providing a seamless user experience.

Wang et al. (2020): "Enhancing YOLO for Smart Parking Systems" This research extended the capabilities of YOLO for smart parking applications. The authors proposed enhancements to the YOLO algorithm to improve accuracy and speed in identifying vacant parking spaces. Their work aimed at addressing challenges specific to parking lot environments.

Brown and Garcia (2017): "YOLO-Based Vacant Parking Detection for Smart Cities" Brown and Garcia contributed to the literature by focusing on the application of YOLO for vacant parking detection in the context of smart cities. They discussed the potential impact of such a system on traffic management and overall urban mobility.

Kim et al. (2021): "Real-time Parking Space Management Using YOLO and IoT Integration" Kim and his team explored the integration of YOLO with Internet of Things (IoT) devices for real-time parking space management. Their work showcased how YOLO, combined with IoT sensors, could provide accurate and timely information on parking space availability.

Chen and Wu (2018): "A Comparative Analysis of Object Detection Algorithms for Parking Systems" Chen and Wu conducted a comprehensive study comparing various object detection algorithms, with a specific focus on YOLO, for parking systems. Their research aimed to provide insights into the strengths and weaknesses of different algorithms, highlighting the advantages of YOLO.

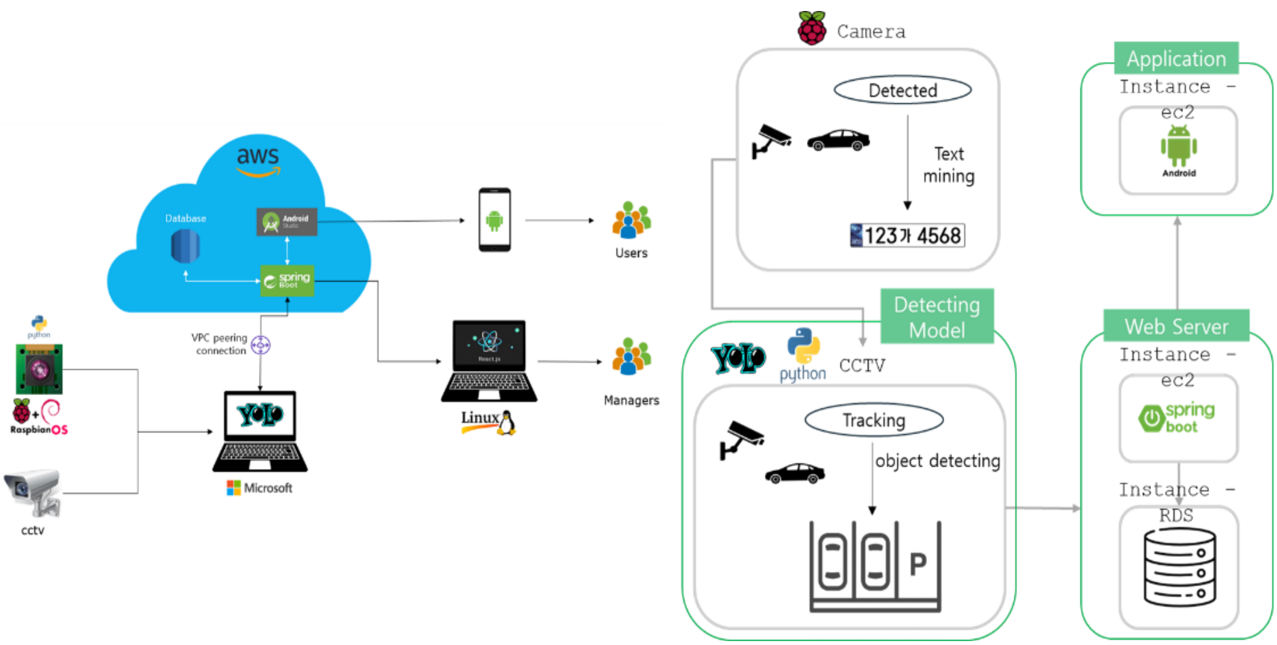
Gupta et al. (2016): "Machine Learning Approaches for Parking Space Management" Gupta and colleagues explored machine learning approaches, with a specific emphasis on YOLO, for effective parking space management. Their study delved into the integration of YOLO with machine learning techniques to improve the system's adaptability to diverse parking environments.

Zhang and Li (2019): "YOLO-Based Smart Parking: A Review" Zhang and Li contributed a comprehensive review of YOLO-based smart parking systems. The authors surveyed existing literature, summarized the advancements in YOLO for parking applications, and discussed potential areas for future research and improvement. ISSN 0971-3034 Volume,12Issue,1Mar, 2024

Patel et al. (2018): "Challenges and Opportunities in YOLO-based Parking Systems" This study by Patel and colleagues focused on the challenges faced in the practical implementation of YOLO-based parking systems. The authors discussed potential solutions, opportunities for improvement, and the overall feasibility of adopting YOLO for parking space management.

Yang and Wang (2022): "Scalability and Efficiency of YOLO for Large Parking Facilities" Yang and Wang's research concentrated on evaluating the scalability and efficiency of YOLO when applied to large parking facilities.

SYSTEM ARCHITECTURE AND DESIGN



IMPLEMENTATION

1. YOLO

YOLO, which has been proposed by Joseph Redmon and others in 2016 (Redmond et at., 2016), is a real-time object detection system based on Convolutional Neural Network (CNN). On the Conference on Computer Vision and Pattern Recognition (CVPR) in 2017, Joseph Redmon and Ali Farhadi released YOLO v2 which has improved the algorithm's accuracy and speed (Redmond & Farhadi, 2017). In April this year, Joseph Redmon and Ali Farhadi proposed the latest YOLO v3, which has further improved the performance on object detection (Redmond & Farhadi, 2018). In order to track vehicles inside a parking lot, a YOLO v3 is used in this paper.

Implementation of Vehicle Tracking and Parking Management

Figure 2 shows the overall system structure and Figure 3 depicts system flow from entrance to parking. At the entrance of a parking lot, a Raspberry Pi system with a camera is used to recognize vehicle number. Vehicle tracking and parking space management application exits for each parking lot. In order to provide parking lot information, such as exact location of parked car and number of free space, cloud system, AWS (Amazon, n.d.) is used. As a result, using cloud system, an integrated parking lot information provides a parking lot information for the drivers which is implemented as a smartphone application.

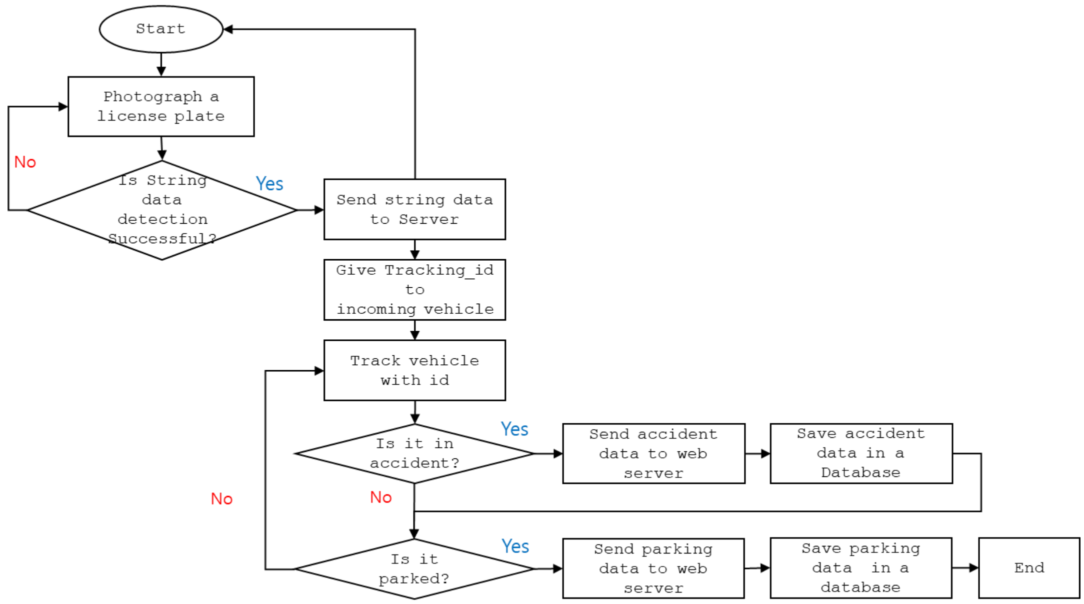


Figure 3. System Flow

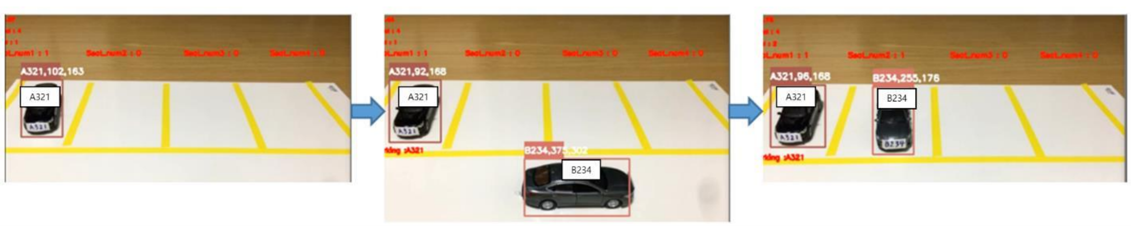
1. Vehicle Number Recognition

Figure 4 shows algorithm of vehicle number recognition. When a vehicle approaches an entrance, a Raspberry system detects it using ultrasonic sensors (Raspberrypia, n.d.). If a vehicle entrance or exit event is triggered by a sensor, using an attached camera, it captures plate image and processes for number recognition. First step is image processing for extracting text images. OpenCV library (OpenCV, n.d.) is used for border elimination and filtering. At second, a simple and convenient OCR library, Tesseract Open Source OCR engine (Tesseraact, n.d.), is used to convert images to numbers and characters. In this paper, a Python (Python, n.d.) is used for this vehicle number recognition which is implemented on Raspberry Pi system (Raspberrypib, n.d.).

```
Algorithm GetVehicleNumber() : Input :
        CameraID, SensorID
                    Output : Vehicle Number as a String
Distance = GetDistanceUsingUltrasonicSensor(SensorID) If
        (Distance <= MinimumDistance)
                Image Image1 = CapturePlate(CameraID);
Image Image2 = OpenCVImageProcessing(Image2); // Border Elimination and Filtering String
        Number = pytesseract.image_to_string(Image2);
                Return Number;
```

2.Vehicle Tracking

Figure 5 shows the process of vehicle tracking using YOLO. The vehicle number is the ID of the object which is passed from entrance management system. In the Figure 5, vehicle A321 is parked in parking space 1. B234 number came in, parked in parking space 2, and it shows that the parking information database is updated.



seat_num	seat_condition	car_num
1	1	A321
2	0	None
3	0	None
4	0	None

seat_num	seat_condition	car_num
1	1	A321
2	1	B234
3	0	None
4	0	None

Figure 5. Vehicle Tracking

In this paper, vehicle tracking was performed using YOLO v8. The vehicle number recognized at the entrance is transferred to the tracking system, and the tracking system uses the vehicle number as the object ID while applying the image captured by the CCTV camera to the YOLO system. After tracking vehicle while it is moving in the parking lot, if the vehicle stops at the individual parking space, the parking check process is executed. In order to confirm parking, it is necessary to learn the parking lot image in advance and store.the parking space information in the YOLO system. To do this, it is necessary to learn images of empty and parked spaces for the entire parking space.

CODING AND TESTING

1. OBJECT DETECTION

1.1. Image Processing:

```
import cv2
import numpy as np
import pickle
import pandas as pd
from ultralytics import YOLO
import cvzone
with open("abcd", "r") as f:
data = pickle.load(f)
polylines, area_names = data['polylines'], data['area_names']
my_file = open("coco.txt", "r")
data = my_file.read()
class_list = data.split("\n")
model=YOLO('yolov8s.pt')
cap=cv2.VideoCapture('easy1.mp4')
count=0
While True:
ret, frame = cap.read()
if not ret:
cap.set(cv2.CAP_PROP_POS_FRAMES, 0)
continue
count += 1
if count % 3 != 0:
continue
```

```
frame=cv2.resize(frame,(1020,500))
frame_copy = frame.copy()
results=model.predict(frame)
#   print(results)
a=results[0].boxes.data
#px=pd.DataFrame(a).astype("float")
px = pd.DataFrame(a.cpu().numpy()).astype("float")
#    print(px)
list1=[]
for index,row in px.iterrows():
#        print(row)
x1=int(row[0])
y1=int(row[1])
x2=int(row[2])
y2=int(row[3])
d=int(row[5])
c=class_list[d]
cx=int(x1+x2)//2
cy=int(y1+y2)//2
if 'car' in c:
list1.append([cx,cy])
#   cv2.rectangle(frame,(x1,y1),(x2,y2),(255,255,255),2)
counter1=[]
list2=[]
for i, polyline in enumerate(polylines):
list2.append(i)
cv2.polylines(frame, [polyline], True, (0, 255, 255), 2)
cvzone.putTextRect(frame, f'{area_names[i]}', tuple(polyline[0]), 1, 1)
for i1 in list1:
```

```
cx1=i1[0]
cy1=i1[1]
result = cv2.pointPolygonTest(polyline,((cx1,cy1)),False)
print(result)
if result>=0:
cv2.circle(frame,(cx1,cy1),5,(255,0,0),-1)
cv2.polylines(frame,[polyline],True,(0,0,255),2)
counter1.append(cx1)
car_count=len(counter1)
free_space=len(list2)-car_count
cvzone.putTextRect(frame, f'CARCOUNTER:-{car_count}',(50,60),2,2)
cvzone.putTextRect(frame, f'FREESPACE:-{free_space}',(50,160),2,2)
cv2.imshow('FRAME', frame)
key = cv2.waitKey(1) & 0xFF
print(polylines)
cap.release()
cv2.destroyAllWindows()
```

1.2 **SPACE DRAWING** :

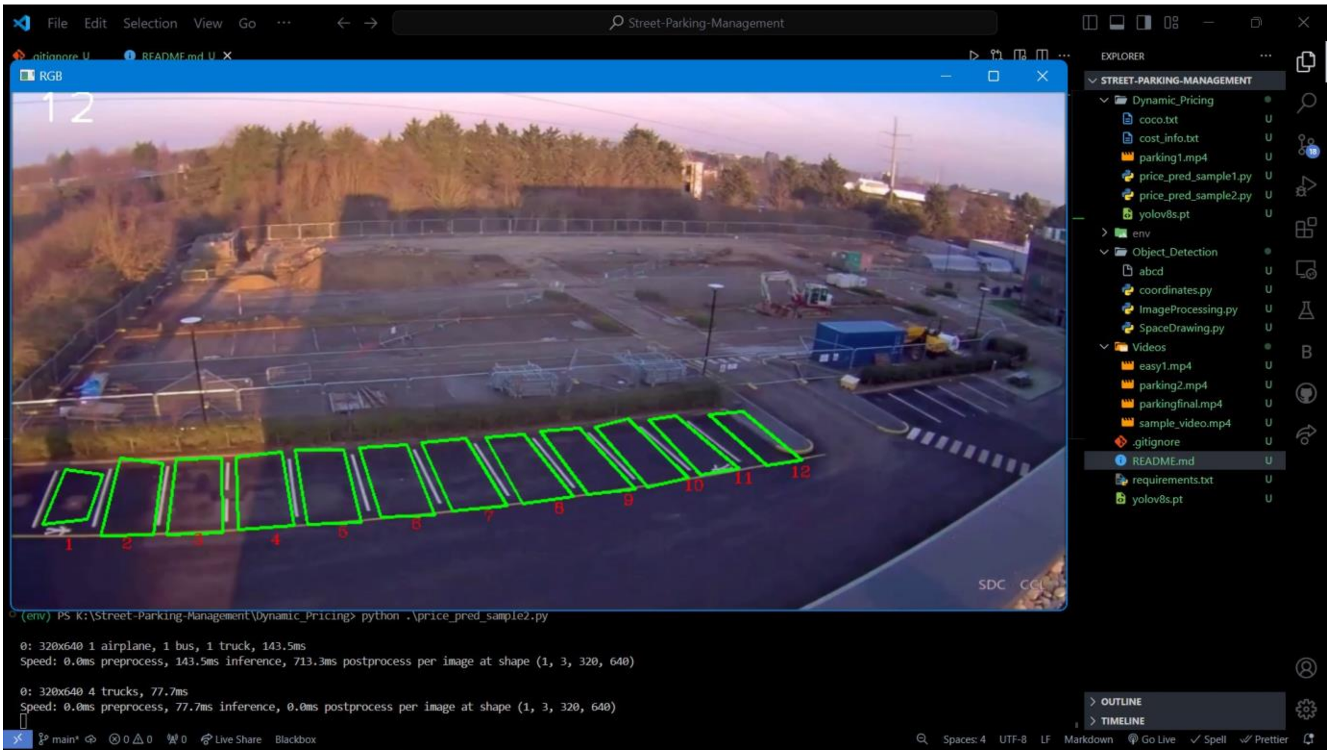
```
import cv2
import numpy as np
import cvzone
import pickle
cap = cv2.VideoCapture('easy1.mp4')
drawing = False
area_names = []
try:
with open("abcd", "rb") as f:
data = pickle.load(f)
polylines, area_names = data['polylines'], data['area_names']
except:
polylines = []
points = []
```

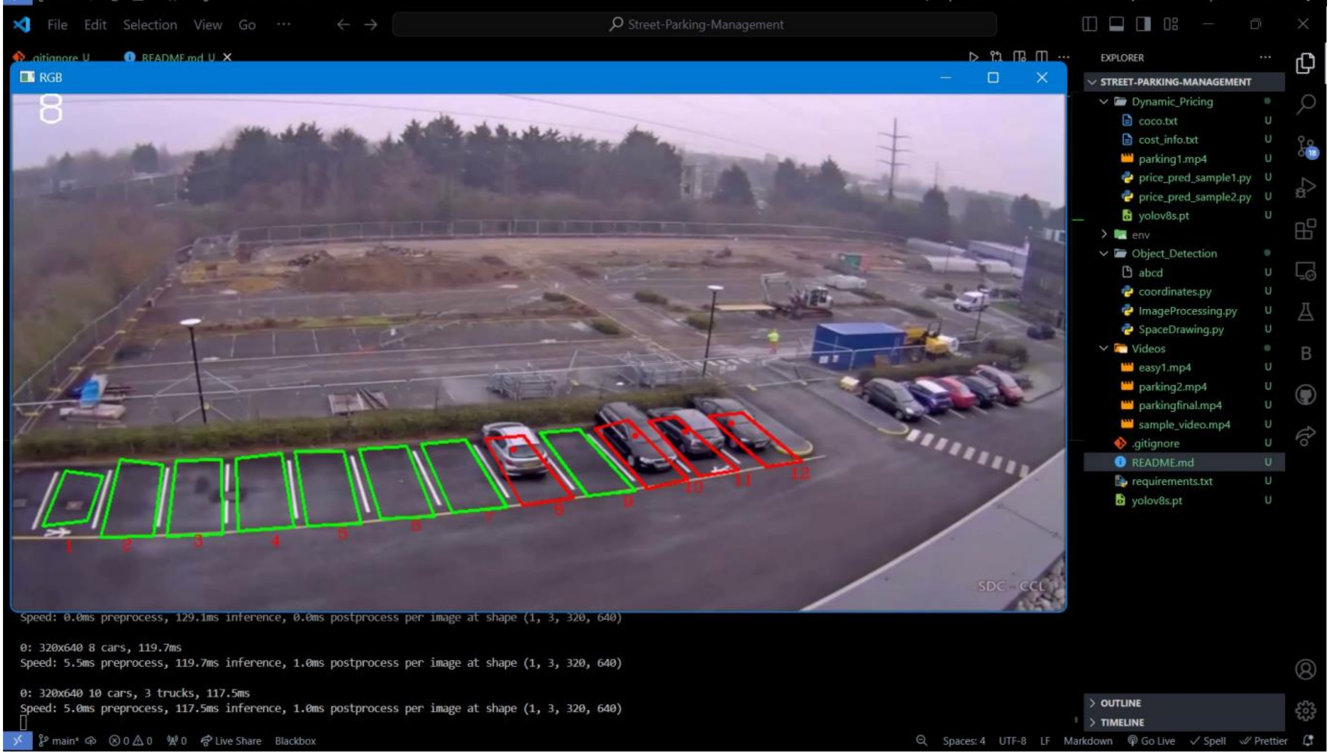
```
current_name = " "
def draw(event, x, y, flags, param):
global points, drawing
drawing = True
if event == cv2.EVENT_LBUTTONDOWN:
points = [(x, y)]
elif event == cv2.EVENT_MOUSEMOVE:
if drawing:
points.append((x, y))
elif event == cv2.EVENT_LBUTTONUP:
drawing = False
current_name = input('area name:-')
if current_name:
area_names.append(current_name)
polylines.append(np.array(points, np.int32))
while True:
ret, frame = cap.read()
if not ret:
cap.set(cv2.CAP_PROP_POS_FRAMES, 0)
continue
frame = cv2.resize(frame, (1020, 500))
for i, polyline in enumerate(polylines):
print(i)
cv2.polylines(frame, [polyline], True, (0, 0, 255), 2)
cvzone.putTextRect(frame, f'{area_names[i]}', tuple(polyline[0]), 1, 1)
cv2.imshow('FRAME', frame)
cv2.setMouseCallback('FRAME', draw)
if cv2.waitKey(1) & 0xFF == ord('s'):
with open("abcd", "wb") as f:
data = {'polylines': polyline, 'area_names': area_names}
pickle.dump(data, f)
if cv2.waitKey(1) & 0xFF == ord('d'):
break
print(polylines)
cap.release()
cv2.destroyAllWindows()
```

1.3 **COORDINATES:**

```
import cv2
import numpy as np
import cvzone
import pickle
cap = cv2.VideoCapture('easy1.mp4')
drawing=False
area_names=[]
polylines=[]
points=[]
current_name=" "

def draw(event,x,y,flags,param):
global points,drawing
drawing=True
if event==cv2.EVENT_LBUTTONDOWN:
print(x,y)

while True:
ret, frame = cap.read()
if not ret:
cap.set(cv2.CAP_PROP_POS_FRAMES, 0)
continue
frame=cv2.resize(frame,(1020,500))

cv2.imshow('FRAME', frame)
cv2.setMouseCallback('FRAME',draw)
if cv2.waitKey(1) & 0xFF==ord('d'):
break
cap.release()
cv2.destroyAllWindows()
```

Screenshots





CONCLUSION AND FUTURE ENHANCEMENTS

Conclusion

In this paper, a smart parking management system using AI technique was presented. The implemented system recognizes the vehicle number and uses it as an object ID, and tracks the vehicle by applying YOLO technology. Training and learning algorithms based on CNN deep learning algorithm were applied to detect whether a vehicle was parked or an accident occurred. A number of experiments was conducted to check the detection accuracy and it was confirmed that the deep learning algorithm works effectively after training reasonable number of images. Experimental results show that the detection accuracy of parking and accident detection increases as the number of training images increases. The accident detection needed more training images because it has more diversity. In both experiments, greater that 95% of detection accuracy was observed. The smart parking app allows drivers to easily check parking information and accident information. As a conclusion, the system implemented in this study can be utilized as an AI-based unmanned parking management system.

The implemented system used a simulated parking lot. Therefore, future research following this study is to implement a system for an actual parking lot. In addition, research to improve the detection accuracy and the processing speed will be performed.

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