ParkSmart

Computer vision based parking system

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Introduction

Our goal is to develop a machine learning model to identify occupied and empty parking lots, as well as count available spaces

Significance

Parking is a struggle for students and staff at KSU. Searching for parking spots without any technology leads to frustration, wasted time, and traffic congestion.

Input & Output:

• Input: Drone footage of parking lots at various times, CarTopView Dataset, survey data from students.

• Output: Data analysis, sentiment analysis, detected occupancies, and empty spots count.

Dataset

- Conducted a survey targeting students who use gate3 and received 115 responses.

- The survey has 18 questions, 15 aimed to understand the attendance patterns throughout the week.

- The responses were all nominal, except the satisfaction rate with the parking which is ordinal, and times of arrival/departure which are interval

1- Survey

```
0    Do you drive yourself or use a driver?
1    Do you attend on Sunday?
2    When you arrive to the campus on Sunday?
3    When you leave the campus on Sunday?
4    Do you attend on Monday?
5    When you arrive to the campus on Monday?
6    When you leave the campus on Monday?
7    Do you attend on Tuesday?
8    When you arrive to the campus on Tuesday?
9    When you leave the campus on Tuesday?
10   Parking Challenge Time
11   How satisfied are you with the availability of parking spaces on campus?
12   Provide any additional comments if you wish
13   Do you attend on Wednesday?
14   When you arrive to the campus on Wednesday?
15   When you leave the campus on Wednesday?
16   Do you attend on Thursday?
17   When you arrive to the campus on Thursday?
18   When you leave the campus on Thursday?
```

When you arrive to the campus on Monday?	Do you attend on Monday?	When you leave the campus on Sunday?	Do you attend on Sunday?	When you arrive to the campus on Sunday?	Do you drive yourself or use a driver?
8:00 AM	Yes.	2:00 PM	Yes.	7:30 AM	Driver.
7:00 AM	Yes.	12:00 PM	Yes.	7:00 AM	Drive yourself.
12:00 PM	Yes.	12:00 PM	Yes.	7:00 AM	Drive yourself.
7:00 AM	Yes.		No.		Drive yourself.
8:00 AM	Yes.	12:00 PM	Yes.	8:00 AM	Drive yourself.
7:30 AM	Yes.	12:00 PM	Yes.	7:30 AM	Driver.
7:00 AM	Yes.	4:00 PM	Yes.	9:30 AM	Driver.
	No.	2:30 PM	Yes.	8:00 AM	Driver.
9:00 AM	Yes.	2:00 PM	Yes.	7:00 AM	Driver.
8:30 AM	Yes.	4:00 PM	Yes.	8:30 AM	Drive yourself.
	No.	10:00 AM	Yes.	8:00 AM	Drive yourself.
9:30 AM	Yes.	2:00 PM	Yes.	7:00 AM	Both.

Dataset

2- Gate3 parking lot videos

1-Manually collected 2 videos of the parking lot using a drone, with 19 minutes and 48 seconds total duration, 35,580 total frames

1- CarTopView Dataset:
Roboflow dataset with 2571 Total Images (2412 Train, 109 Validation, 56 Test).
It has 3 classes; Car, Empty, and Disabled.

● Car	31
● Disabled	4
● Empty	2

Methods

Exploring the problem through the survey

We performed Sentiment Analysis on the comment's column using a pre-trained model from Hugging Face called "bhadresh-savani/distilbert-base-uncased-emotion".

This model can pick up on a range of emotions, including joy, sadness, anger, fear, and more.

Methods

Gate3 parking lot videos

1- Pretrained Single Shot Multibox Detector (SSD):
- resized frames to fit model requirements
- Detect and draw bounding boxes on the detected objects for visual feedback.

Evaluated by using average precision, average recall, approximate F1 score performance metrics

2- YOLO11n:
- pretrained (COCO) model

- Trained on CarTopView Dataset with Gridearch to find the best learning rate and epoch
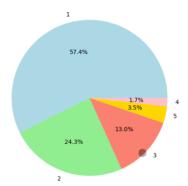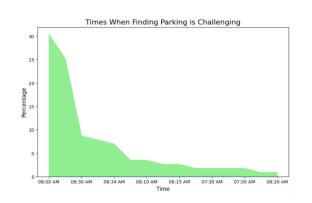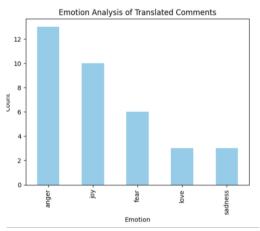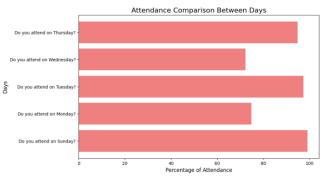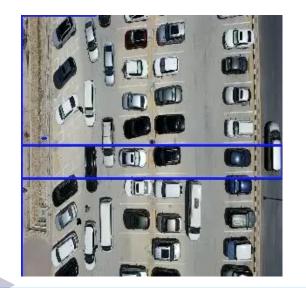
Exploring the problem through the survey
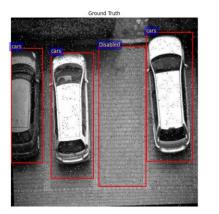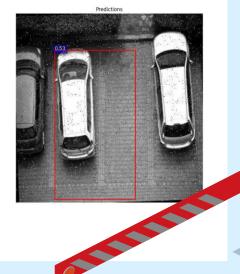
Preliminary Results

Gate3 parking lot videos

The SSD pretrained model was not even close to detecting the cars and empty spaces in our dataset

Evaluating SSD For the CarTopView Dataset:
Average Precision: 0.0314.
Average Recall: 0.1352.
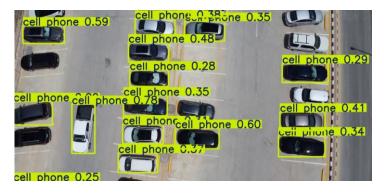**Approximate F1 Score: 0.0510**
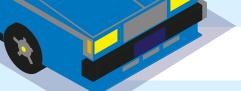
Preliminary Results

Gate3 parking lot videos

- YOLOIIv showed more promise, but detected that the cars were cellphones from a top-view

- However, it had no problem detecting cars from a front-view

CarTopView Dataset

After training YOLO on CarTopView dataset the best results from grid search: lr0=0.001 and epochs=50
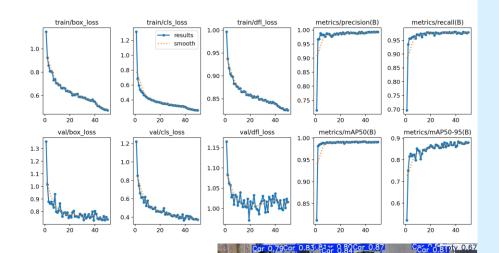
Confidence = 0.5:
Average Precision: 0.992
Average Recall: 0.961
mAP50: 0.98
mAP50-95: 0.879

Next Steps

After deploying the model, we plan to implement a counting system to show the number of empty and occupied parking lots

Thank you for listening!

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