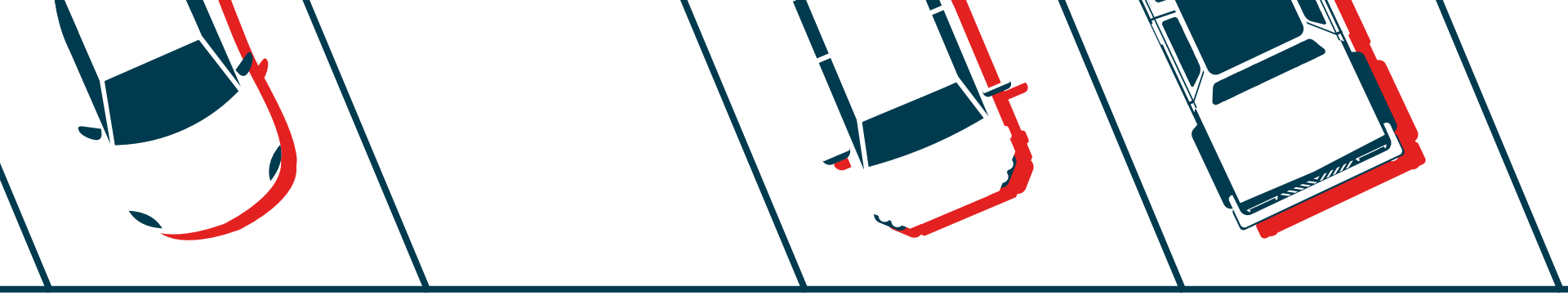
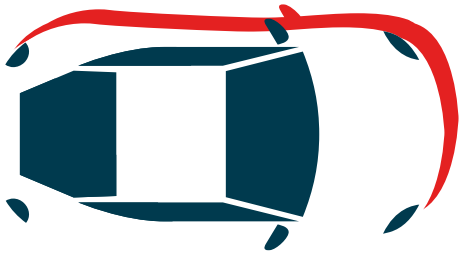


Project Proposal

Parking Lot Vehicle Classification

Team Members: Aniruddha Srinivasan, Coleman Todd, Fabianna Barbarino, Jacqueline Mioduski, Spencer Cho, Tyler Roosth

Presentation Contents



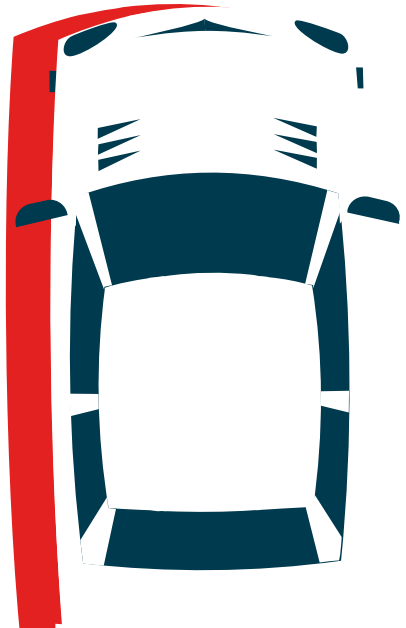
Problem Background

- Increased vehicle traffic as business growth occurs
- Security personnel need to identify a large number of cars simultaneously
- Analysts need to track heavier traffic flow

Needs Statement

Parking lots are frustrating!

- According to the National Safety Council (NSC), "tens of thousands of crashes occur in parking lots and garage structures annually, resulting in hundreds of deaths and thousands of injuries" [1].
- Allows for quicker response time from security personnel
- Monitor the parking lots in order to recognize traffic patterns
- Improve the overall flow of traffic and customer satisfaction



Goals & Objectives

Our main goal to build a containerized app that detects and tracks vehicles across a parking lot and continually logs the driving patterns.

- ➢ Parked, illegally parked, stopped driving, speeding, etc.
- ➢ Monitored through the user interface by security personnel or data scientist.

Vehicle detector should track at least 5 cars

Cameras will be 12 feet off the ground looking out

Bounding Boxes around the cars

The coordinates will be sent to our database

Tie the back-end with the front-end successfully

GUI should work in real time

Implementation works as a desktop app on a GPU workstation/laptop

Literature Review

Research Projects

ArcVision

Hackathon Project using OpenCV & YOLO

GUI includes video feed, parking map view, analytics, & license plates

Ultrasonic sensor system

Use sound to detect speed and type of vehicle, as well as count of vehicles

Commercial Products

Smartpark System

Capable of supporting thousands of parking spaces

SmartCloud for data processing/ analytics

ParkSol

For mid-size and small businesses

On-premises solution

M-Gage Node Pucks

Magnetic field detectors

Placed underground (at each parking space)

Design Constraints and Feasibility

Our Design Constraints are:

- USB Camera
- Experience in ML
- Due Date

One issue is the fact that we will need to have the camera be around 12 feet high, looking out, preferably at some sort of parking lot.

Evaluation of Alternative Solutions

Detection Algorithms

YOLOv7

Fastest

Most accurate for object detection

Mask R-CNN

Slower

Most accurate for object area

Tracking Algorithms

DeepSORT

An established method

Poor FPS

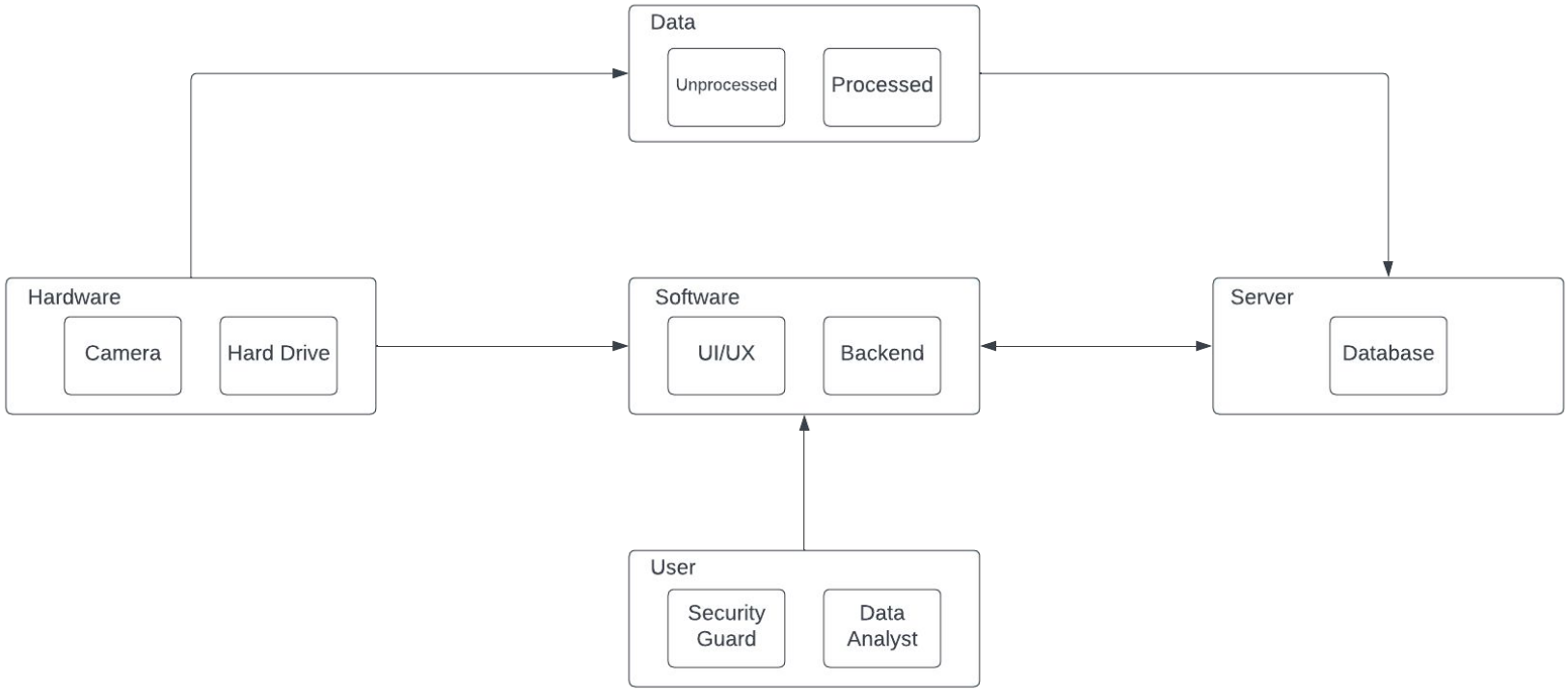
ByteTrack

Higher FPS than DeepSORT

SMILETrack

Cutting edge- Ranked the highest for HOTA, MOTA, & IDF1

Proposed Design



Approach for Design Validation

- MVP Requirements
- 1 USB Camera should be able to send a live feed to our application (up to 5 cars in frame)
- Web/Desktop Application should be able to view this feed, view details of parked, illegally parked, speeding , stopped vehicles
- Business analyst view should update with data from database
- Application should run in a container smoothly with reasonable usage of resources

ML Detection

5 cars 10 FPS
>85% accuracy
Vehicle status

Backend

SQL Database
Record position, time, status

GUI

2 separate views
Filter by status
Trending charts

Infrastructure

Runs in Docker container
Reasonable resource usage

Economic Analysis and Budget

We found that, if this project were to go commercial, we would need a few things to ensure everything goes smoothly.

- Manufacturing for USB Cameras
- Database on a Cloud to store data
- IT Team to handle software support
- Compliance with regulations
- A system to let customers report the USB Cameras for being broken

Regulations

Regulations we have to be followed, specifics can change from state to state, as well as following FCC guidelines.

Database

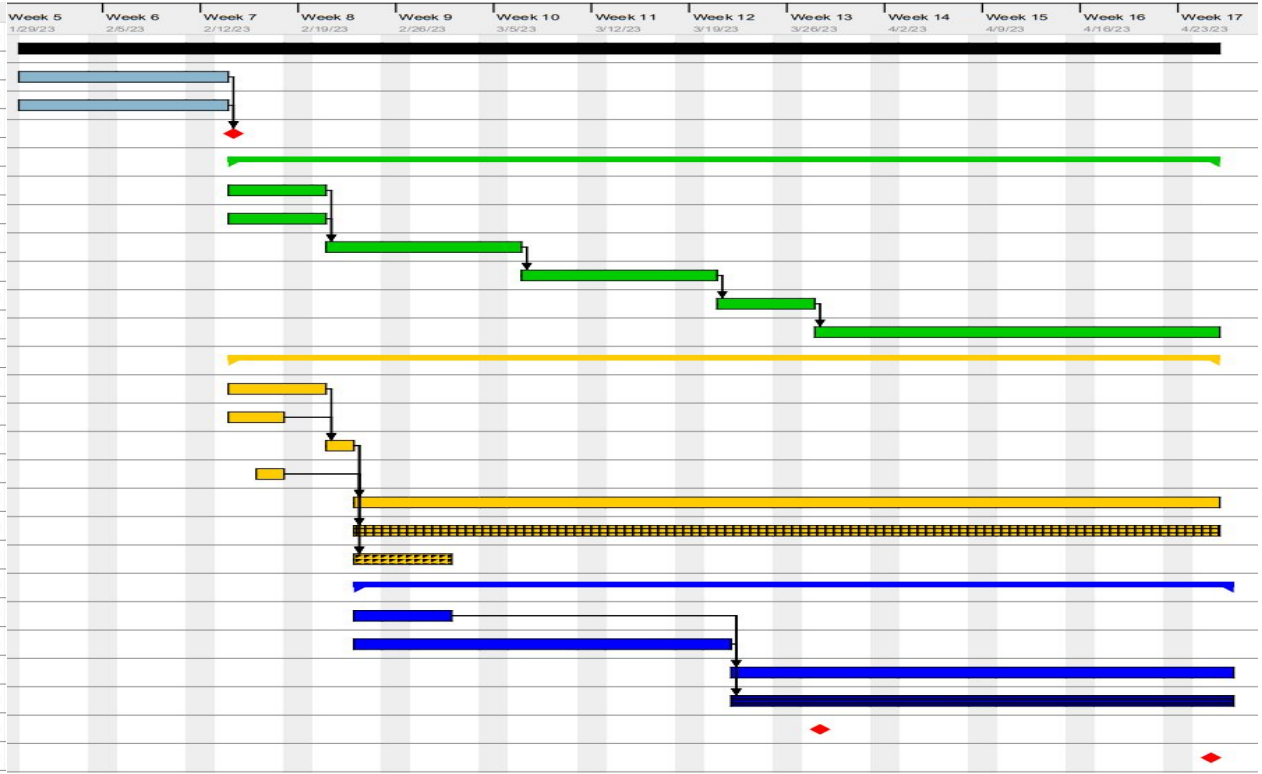
The Database can be hosted on a cloud which can be found from numerous vendors, Amazon, Google, Azure, etc...

USB Cameras

The USB Cameras used are generic and therefore are easy to find and produce.

Schedule of Tasks

Name	Begin date	End date
Vehicle Classification Project	1/30/23	4/25/23
Project Proposal	1/30/23	2/13/23
Project Proposal Slides	1/30/23	2/13/23
Project Proposal Presentation	2/14/23	2/14/23
Vehicle Classification Machine Learning	2/14/23	4/25/23
Organize Machine Learning Data	2/14/23	2/20/23
ML Model Brainstorming	2/14/23	2/20/23
ML Model Implementation	2/21/23	3/6/23
ML Model Training	3/7/23	3/20/23
ML Evaluation	3/21/23	3/27/23
ML Tuning	3/28/23	4/25/23
Database	2/14/23	4/25/23
Database Schema Design	2/14/23	2/20/23
Database Server Setup	2/14/23	2/17/23
Database Table Creation	2/21/23	2/22/23
Database I/O Format	2/16/23	2/17/23
Database Management Software I...	2/23/23	4/25/23
Security User Data Access Organization	2/23/23	4/25/23
Analyst User Data Access Organization	2/23/23	3/1/23
UI	2/23/23	4/26/23
User Interface Sketch	2/23/23	3/1/23
User Interface Prototype	2/23/23	3/21/23
User Interface Security	3/22/23	4/26/23
User Interface Analyst	3/22/23	4/26/23
CDR Presentation	3/28/23	3/28/23
Project Demo	4/25/23	4/25/23



Project Management and Teamwork

- Members divide into 3 pairs
- Tasked with module connections
- Assignments are flexible
- 2 in-person meetings weekly

ML Recognition

Spencer Cho & Tyler Roosth

Database Server Management

Aniruddha Srinivasan & Coleman Todd

User Interface

Fabianna Barbarino & Jacqueline Mioduski

Docker & Documentation

All Member & Rotating

Societal, Safety, and Environmental Analysis

Beneficial Impact

- ★ Increase in parking lot safety
- ★ More efficient and satisfying shopping experience

Detrimental Impact

- ★ Potential loss of privacy due to information being stored and cameras recording

Safety Precautions we must take

- ★ Conducting tests with camera 12 feet high (ladder safety)
- ★ Inclement weather may damage camera

Environmental Impact

- ★ Carbon emissions from streaming video footage
- ★ Only keep cameras on during business hours

RESOURCES

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RESOURCES cont.

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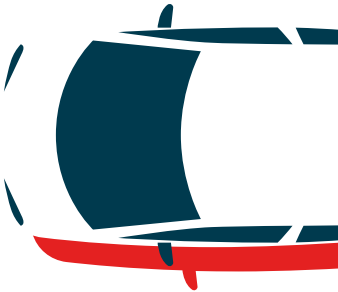

THANK YOU!

Do you have any questions?