

# Vehicle Recognition for Public Safety



**Remington Greko (Computer Science)**  
**Spencer Hirsch (Computer Science)**  
**Thomas Johnson (Software Engineering)**  
**Alexis Nagle (Computer Science)**

# Introduction



- Utilize machine learning to recognize vehicles based upon make, model, and/or license plate
- Employ new technology to aid in public safety
  - Amber Alert/Silver Alert
  - Vehicle Theft
  - Evading Arrest/Fleeing and Eluding
- Allows for more organized pursuit tactics

# Description of Current Systems



- Law Enforcement officers actively searching for involved vehicles
- Rely on participation of civilians to report on involved vehicles
- Some areas utilize license plate readers to identify plates involved in the alert
  - Only efficient in the case that a license plate is provided

# Opportunities/Pains and Associated Trends (identifying problems to solve)



# Initial Opportunities/Pains (Pains -> opportunities)



- **Vehicle recognition**
  - Utilize machine learning to eliminate man power in identifying vehicles upon make, model, color, and/or licence plate
- **Track multiple vehicles in real time**
  - Utilize Python library to manage object tracking of numerous vehicles at once
- **Create a database with unsolved involvements for a constant search**
  - Will allow for multiple search queries at one time

# Associated Trends

(pains + trends -> better opportunities)



- Take advantage of the efficiency and innovation of machine learning in identifying vehicles
- Utilize computer vision for object recognition and data collection
  - Car details and license plate information
- Pre-existing use of cameras along roads to capture different information
  - Red light cameras
  - Speed cameras
  - Traffic cameras

# Feedback of User 1 on Opportunities/Pains



1. Does the user agree/disagree with the opportunities/pains?

Source:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9966104/>

This article identifies the challenges of vehicle identification. They recognize that to create a successful vehicle identification tool it is necessary to utilize a deep-learning model. They also stress the importance of integrating not only an image classifier but also a multi-object tracker and object detectors.

# Feedback of User 2 on Opportunities/Pains



1. Does the user agree/disagree with the opportunities/pains?

Source: <https://digital.library.txstate.edu/handle/10877/13507>

This user addresses the possible usage of vehicle detection to aid in AMBER/silver alerts. They discuss how vehicles need to be able to be detected with a variety of possible information (color, type, license plate, and brand). They also discuss that to properly identify vehicles they will need a deep learning model to classify vehicles and an object detector to detect and extract images of vehicles along with characters from the license plate.



# Feedback of User 3 on Opportunities/Pains



1. Does the user agree/disagree with the opportunities/pains?

<https://www.sciencedirect.com/science/article/pii/S2405959516300169>

This paper discusses the benefits of implementing a deep learning system to either be integrated with and emergency response system or replace it. This system would be able to detect natural disasters and criminal behaviors. The paper discusses the different methods currently in place and their faults.

# Summary of User Feedback on Opportunities/Pains



	<b>Opportunity/ Pain 1</b>	<b>Opportunity/ Pain 2</b>	<b>Opportunity/ Pain 3</b>	<b>Suggestions</b>
User 1	The user recognizes that the use of AI for surveillance is up and coming. Especially with a large usage for license plate recognition.	The user stresses the importance of implementing multiple object detectors as well as a multi-object tracker to aid in the implementation of vehicle detection.	The user does not directly identify where the search queries would come from or a direct use of the software.	
User 2	The user recognizes the importance of identifying vehicles with the inclusion (or lack of) many characteristics such as color, make, model, and/or license plate.	The user identifies that to implement this type of software both a deep learning classifier and an object detection algorithm are needed.	While the user does not directly talk about the use of a database for a constant search, I believe they would be in support as they talk about using the software to aid in the search of AMBER alerts which would require a constant ongoing search.	
User 3	The user recognizes that there is usefulness in utilizing computer vision paired with deep learning	This user does not mention the importance of multiple vehicle tracking but it can be inferred that they believe it to be necessary	The user does not mention the use of a database for such events however the system they propose would require a constant search for parameters.	Create a system that can serve more than one singular purpose.

# Proposed Opportunities/Pains



1. Use machine learning and computer vision as a cost effective and efficient solution to a real world problem.
1. Allow for the identification of numerous vehicles.
1. Time efficient allowing data to be collected over a large area in short amount of time.

# Ideas to Create Value/Benefit: Core Features of the System (Ideas for solving the problem—"how")



# Initial Core Features of the System



- **Object Identification**
  - a. Identify vehicles in the frame and categorize them
  - b. Find vehicles matching make, model, color, and/or license plate
  
- **Multi-vehicle tracking**
  - a. Identify multiple vehicles in the frame at a specific time
  - b. Be able to single out any cars that match the description
  
- **Report matches**
  - a. Identify direction the car is moving so law enforcement can track and/or engage
  - b. Report possible license plate numbers in the case that the original identification of the vehicle did not contain a license plate number

# Types of Users



- **Law Enforcement**
  - Allow law enforcement to have more eyes on the roads to look for specified vehicles
  - Allow law enforcement to focus on other aspects of their job as they don't have to worry about manually searching for the specified vehicles
- **Federal Emergency Management Agency**
  - This is the federal department that issues and manages AMBER alerts

# What can each type of users do?



- **Law Enforcement**
  - Identify vehicles of interest
    - ▣ Vehicles suspected to be involved with AMBER/Silver alerts
    - ▣ Vehicles suspected to be involved with ongoing crimes
    - ▣ Vehicles reported stolen
  - Identify direction of movement for identified cars
    - ▣ Track the vehicles
    - ▣ Plan to engage with the vehicle
- **Federal Emergency Management Agency**
  - Manage progress in ongoing AMBER/Silver alerts

# Feedback on features from User 1



1. Does the user agree/disagree that the features are an improvement and create value?

The user agrees with the usage of surveillance cameras to not only detect and track vehicles but to be able to identify and categorize them as well. They primarily focus on license plate identification, but other identification types are considered as well.



# Feedback on features from User 2



1. Does the user agree/disagree that the features are an improvement and create value?

The user agrees with the necessary features of object detection/tracking and the use of object classification base upon a variety of characteristics. The user does not directly talk about the feature to report full or partial matches to law enforcement; however, they do imply it by discussing the need to identify license plates of possible matches and the want to implement this feature in instances of missing persons.

# Feedback on features from User 3



1. Does the user agree/disagree that the features are an improvement and create value?

This user is in support of using deep learning to aid in warning of emergency situations. The user specifically talks about using deep learning as an early detection system. Our proposed idea is to utilize machine learning as a way to resolve emergency situations or aid in the resolution of them.

# Summary of User Feedback on Features



	<b>Feature 1</b>	<b>Feature 2</b>	<b>Feature 3</b>	<b>Suggestions</b>
<b>User 1</b>	The user strongly agrees in the usage of camera to identify vehicles, especially for license plate recognition.	The user stresses the importance of integrating object detectors and a multi-object tracker.	This user does not directly focus on an application for the vehicle detection but more so the capability to identify vehicles.	
<b>User 2</b>	The user aligns with the concept of identifying vehicles based upon a set of characteristics.	The user agrees that to identify vehicles it is important to have object detection/tracking algorithms.	While the user does not directly discuss reporting matches, they do discuss using the system to find matches for the use of law enforcement and the concept of gathering data (license plate) of possible partial matches.	
<b>User 3</b>	Object identification is the primary topic that this user finds important.	Managing multiple objects is one of the most fundamental principles that would be necessary to achieve this user's goals.	With this user discussing a new addition to an EAS and reporting to law enforcement. The user would completely agree with this feature.	

# Proposed Core Features of the System



- **Identify vehicle based on given criteria**
  - Use a neural network to efficiently and accurately identify a vehicle in traffic given make, model, and/or license plate information
- **Have the ability to identify numerous vehicles in real-time.**
  - Extract individual images of all vehicles in the frame of the camera
- **Report Vehicles when full or partial matches are found**
  - If a license plate was given, when the complete match is found the system will report the location spotted as well as the direction of movement
  - If a license plate was not provided, partial matches will be made when the physical description (color, make, model) are identified. The system will report both the license plate on the partial matches along with a current location and direction of movement.

# Tools (languages, libraries, packages) that can help with the core features



- Python 3.11+
- Convolutional Neural Network libraries for Python
  - TensorFlow
  - Keras
  - PyTorch
- Computer vision library for object tracking
  - OpenCV implementations such as BOOSTING, MIL, KCF, CSRT, MedianFlow, TDL, MOSSE, and GOTURN.
- Camera
  - Currently searching for a camera with adequate specs.

# Potential technical challenges of the core features



- Training neural network to accurately identify vehicle based on make, model, and/or license plate
  - Datasets containing make and model information already available
- Queue to identify numerous vehicles in the same frame
  - Find a way to identify more than one vehicle passing the camera at a single time