Requirements

Northrop Grumman Team

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1 Overview

1.1 Purpose of Document

This is a requirements document for a research project which will present Northrop Grumman (the sponsor) with results of applying machine learning algorithms to the problem of tracking and classifying vehicles in a video. This document describes the scope, objectives and goal of the new system. In addition to describing non-functional requirements, this document models the functional requirements with use cases, interaction diagrams, and class models. This document is intended to direct the design and implementation of the target system in an object oriented language.

1.2 Project Summary

Project Name: TBD
Project Sponsor: David Motta, Sr. Principal Systems Engineer, Northrop Grumman
Project Members:
Justin Davis, Communications Lead
Zhengwu Yuan, Source Code Control Lead
Valliappan Chidambaram, Requirements Lead
Paris Dinh, Implementation Lead
Amari Hoogland, Architectural Lead
Sofia Lange, Documentation Lead
Lei Teng, Testing/Analysis Lead
Kamen Shah, Deployment Lead
Responsible Users: Christian Butterfield, Principal Systems Engineer, Northrop Grumman

1.3 Background

Northrop Grumman is a "leading global security company providing innovative systems, products and solutions in autonomous systems, cyber, C4ISR, space, strike, and logistics and modernization to customers worldwide. Their vision is to be the most trusted provider of systems and technologies that ensure the security and freedom of our nation and its allies. As the technology leader, they will define the future of defense - from undersea to outer space, and in cyberspace."

The goal of Northrop Grumman's project this year is to create a time dependent model to classify and track vehicles in video for use in real-time applications. Last year, students tested a variety of algorithms to perform this task, and were able to achieve a tracking accuracy of 56.9%

and a classification accuracy of approximately 80%. The algorithms they tested treated each frame of video independently and thus had temporal instabilities in classification. This year's task is to test a variety of methods that are time dependent to see if we can improve the classification accuracy.

1.4 Scope

At a minimum, Northrop Grumman would like us to investigate attention, long short-term memory (LSTM), recurrent neural networks (RNN), and temporal convolutional neural networks (TCNN), but they are also open to other methods we may find in the course of our research. We will implement/research at least 4 and at most 10 models incorporating these or other techniques.

Writing a program to use the models we create in a production environment is outside of the scope of this project, though we will probably write something similar for testing purposes.

1.5 System/Project Purpose

To determine which of available existing machine learning techniques are the most accurate and efficient at classifying vehicle types in real time.

2 Functional Objectives

1. Object tracking
2. Vehicle classification by car type at highest granularity possible with a quality data set.
3. Run properly on specified computer

2.1 High Priority

1. Implemented models must be trained with chosen data sets.
2. Implemented models must produce vehicle classifications for overhead point of view.
3. Models must track and predict in real-time.
4. At least Attention, LSTM, RCNN, TCNN are implemented and analyzed.

2.2 Medium Priority

1. Implemented models must produce vehicle classifications for eye level point of view.
2. Obtain classification accuracy of model prediction.
3. Report tracking accuracy of model prediction.

2.3 Low Priority

1. Implement additional models.

3 Non-Functional Objectives

1. Models correctly classify vehicles at least 80% of the time.
2. Models achieve real-time prediction of objects (8-12 frames per second).
3. Models can be trained within a reasonable amount of time. The specific benchmark we wish to reach is to be determined.
4. Models are robust and able to be trained on new data.

4 Use Cases

Use Case	tracking high-priority vehicles
Primary User	Law enforcement/security detail
Description	Apply vehicle classification system to aid in keeping track of a certain important vehicle, such as a government official's vehicle, throughout a given event for security purposes.
Preconditions	known specific vehicle type, intended path to follow, applicable tracking system (out of scope)
Postconditions	vehicle is properly classified/identified to enable tracking

Use Case	tracking criminal vehicles
User	Law enforcement/other government agencies
Description	Apply vehicle classification system to aid in keeping track/identifying a criminal/target vehicle amongst other ongoing traffic.
Preconditions	target vehicle type, applicable tracking system (out of scope)
Postconditions	possible matching type vehicles identified in a given area

Use Case	Census data - traffic analysis
User	City/State/Federal government
Description	Track usage of public roadways and analyze where certain vehicles are more/less common and see how this describes or impacts communities
Preconditions	Traffic cam footage
Postconditions	Statistics on vehicle usage

5 Change Management

Date	Requirement	Notes	Approval