

Raytheon

Luyuan Yuan Yan(Chloe) - ly6pc

Sania Rasheed - sr2xn

Deepaloke Chattopadhyay - dc2hd

Implementing Real-Time Machine Learning for Object Detection and Classification in All-Electronic Tolling Systems

Brief Description:

Advancements in technology have paved the way for innovative use cases in the Highway Tolling space. Low cost sensors and image processing applications have evolved Electronic Tolling Systems and their use in commuter convenience, traffic management, security and law enforcement. Raytheon, the industry leader in highway tolling technology, provides highly advanced All Electronic Tolling Systems (AETS). Right from upgrading existing tolling systems to new construction, they bring two decades of experience in turn-key open-road tolling solutions that seamlessly integrate with tolling and traffic management systems. Their capabilities in system-engineered vehicle sensing and classification technologies maximize income collections with superior image clarity and automation.

Our goal is to explore the use of machine learning in the AET space in an attempt to advance Raytheon's AET capabilities beyond traditional image processing. The main goal is to integrate machine learning into Raytheon's existing AET systems by developing innovative, trainable modules for object detection and classification. Besides, we would also explore the ability to deploy these modules on live sensors and cameras on toll roads to facilitate and reap the benefits of real-time computation. Use cases for detection of objects and classification, although unclear for now, are likely to include vehicle detection, vehicle-type classification and licence plate number capturing. They may also be extended to capture other context data such as vehicle color, number of passengers and vehicle speed.

Real-time identification of features from a moving vehicle would not only require exploring existing algorithms in Machine Learning and Computer Vision, but also necessitate the use of competent hardware. So, an additional goal to successfully mobilize these automated systems would be to recommend efficient hardware architecture and set up appropriate data pipelines to propose a viable production framework. The type of data provided to us by Raytheon will become clearer post preliminary meetings, but is likely to include video feed from toll cameras and relevant sensor captured information.

In addition to vehicle detection and context data capture through object detection and classification, we also intend to showcase practical use of this project by using the outcome to provide traffic related insights. This may include information on traffic density by time of day and year for specific locations of interest. A potential use case could also be to predict the location of chosen vehicles for interests of security and law enforcement. Other use

cases and insights will unveil themselves post initial context setting meetings with the client as well as throughout the entirety of the project.

Stakeholders:

Raytheon:

- ❖ Business Contact: Kent Pride
- ❖ Project Mentors: Alfonso Lopez and Jay Farmer

DSI:

- ❖ Faculty Advisor: Don Brown

Other Potential Stakeholders:

- ❖ Government: This project can provide effective solutions for efficient and cost-friendly electronic tolling systems serving a wide range of customers in the Government ranging from traffic management authorities to law enforcement bodies.
- ❖ Non-profit Organizations and Scientists: With the increased number of vehicles on the road, the amount of air pollution has become a concern. The outcomes of this project may facilitate research in these areas.
- ❖ For profit Organizations, example Insurance Companies: With more efficient tolling systems, the amount of traffic could be reduced, which could lead to less incidents on the road. Insurance companies could benefit from such data.

Procedures:

We will be essentially meeting with our capstone group 3 times per week:

Meeting With Advisor:

- ❖ Every Thursday, from 3-5 PM
- ❖ This is when we will present our progress on the capstone project and propose work for the next week
- ❖ Clarify any questions/concerns we might have with our advisor
- ❖ Get feedback from other groups regarding the project

Meetings With Sponsors:

- ❖ Ideally, we would like to meet with the sponsors biweekly and change the frequency in the future based on progress

- ❖ Give updates to the sponsor of the progress on the project
- ❖ Clarify any questions/concerns with the sponsors

Meetings With Group Members:

- ❖ Meet up with group members outside of class at least once a week
- ❖ Short discussion session with members on a daily basis
- ❖ Track progress and figure out solutions to problems each team member has
- ❖ Propose future work, distribute tasks and ideate
- ❖ Work on coding for the modules and update online documentation regularly.

Decision Making Process And Changes To The Charter:

Any decision making process should be based on mutual agreement from all group members. Any changes that will be made to the charter need to be agreed upon by all the members of the team and the sponsors/advisor should be informed of the changes made.

Roles and Responsibilities:

Roles:

In the project, we would like that all 3 of us contribute equally to all aspects of the project. Coding, analyzing/interpreting data, setting up product frameworks and data pipelines and summarizing the findings of the data (final report) should have contribution from each member of the team. Roles such as Project Manager, Product Manager, Data Engineer, Machine Learning Researcher are all relevant to this project and will be executed by each member of the team at different times and phases of the project based on the requirements.

Responsibilities:

- ❖ Conduct background research to get a better understanding of the subject at hand
- ❖ Define the scope of the project and make sure the sponsor is in agreement
- ❖ Communicate effectively with team members to make sure everyone is on the same schedule as to what progress needs to be made each week.
- ❖ Use GitHub to compile and keep track of the coding done by all the group members
- ❖ Follow non-disclosure agreement and get document reviewed prior to publication