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AmberVision

Ben Fernandez

As the world of data moves from mere gigabytes to exabytes of data points, there is a rising importance of making sense of this data. That is the primary goal of artificial intelligence and within that, Computer Vision focuses on images as a data type to see what can be pulled out and put together from images. This subfield has grown rapidly and can be seen through innovations like self-driving cars, facial recognition software, robotics, and many more. In parallel, the amount of images on the Internet is rapidly rising and adding to the data pool to be tapped into. In recognizing the current state of deep learning models as well as the increased access to images, our team looks to affect the community with this technology. We see an opportunity to assist families, the public, and governing bodies like law enforcement in Amber Alert searches. Taken from the official website itself, “The AMBER Alert™ Program is a voluntary partnership between law-enforcement agencies, broadcasters, transportation agencies, and the wireless industry, to activate an urgent bulletin in the most serious child-abduction cases. The goal of an AMBER Alert is to instantly galvanize the entire community to assist in the search for and the safe recovery of the child.” (DOJ, 2019) An AMBER alert usually consists of a description of the child-abduction case including last location seen and suspect vehicle. Using state-of-the-art object detection models, we look to help identify those vehicles using a network of traffic cameras and in doing so, contribute to the goal of AMBER Alerts in search and recovery of the child. The team is seeking funding for this specific venture that has the chance to change the lives of many. With funding received, our team can increase the resources for development and server computation in order to get a product to market in a shorter time frame.

Many approaches have been taken in deep learning to detect cars and other vehicles in images and as we plan to use those existing architectures, we are aware of the technical challenges that will come with refitting these models for the data and images we are analyzing. Most traffic cameras from initial research are not of highest resolution and the images as a result will be harder to analyze. On top of this, most existing models tackle one output of detection while our goal is to combine different outputs for one object. For example, we would aim to detect a red sedan in the image or video feed which could result in multiple detection models being used on one image. Initial research has led us to looking into current models like YOLOv3 (Redmon, 2018) for real time object detection but fitting this model on traffic camera feeds is not trivial. Acquiring data will also be a challenge as we are looking for live data in proximity to Washington DC. Our initial research has led us to DDOT’s Washington DC traffic cameras which as stated earlier are not high resolution and have low frames per second. In addition to building/using detection models and acquiring data, our goal is to surface the information in a useful and effective way. This means creating a frontend for our data and analysis to be displayed which will require development in data engineering and user experience. All together, the technical challenges encompass in acquiring valuable data, building/using effective and accurate object detection models, and creating a frontend for users to view the analysis. This full-stack approach will not be an easy feat but we are confident and inspired to help do work towards this specific need. Ultimately, we see the future of AI more as augmented intelligence rather than artificial intelligence as we aim to help people using the technology that exists today.

Kyle Rood

Computer Vision is an important subset of Machine Learning, and can be leveraged to analyze massive amounts of data in seconds. Slow data analysis is often a bottleneck for completing many tasks, and one place we think we can help this bottleneck is with the AMBER Alert™ system for missing children. AMBER Alert™ is a partnership between law enforcement, wireless carriers, and broadcast companies to notify as many people as possible if a child is missing. (Office of Justice Programs, 1996) We are looking for investors in our tool, AmberVision, which will ensure law enforcement finds the person they are looking for instantaneously.

We will be making use of Washington, D.C.’s traffic camera network to answer the question: can we find a car (down to color, size, and location in time and space) given a large array of cameras? Using a deep learning approach, we will create models to identify cars, and then classify those cars into color and sizing categories. The problem with traffic cameras is they are pretty low resolution, so getting an accurate identification of the type of car is very difficult. We may need to experiment with some deep learning techniques (such as transfer learning or combinations of networks) to sort this problem out.

Another one of our technical challenges is that our product needs to be fast. If the police want to see all the red midsize cars in the city right now, we do not have time to run through a very complex model. We will probably resort to using a single shot detection algorithm, like YOLO (You Only Look Once), or something similar. (Redmon, Farhadi, 2018). This type of algorithm is advantageous in comparison to other similar technologies, like RCNN. Other neural networks take thousands of evaluations to output a single class, but YOLO does this using one evaluation. (Redmon, Farhadi, 2018) This is a key to doing real time detection.

Though we will be using an already established model, another technical challenge will be getting data that we can fit to the model. The first piece of data we will collect is the traffic camera footage around DC. We have set up an arrangement with TrafficLand for a student license to their traffic camera API. They sent us an NDA to protect their data, and we are simply waiting on a signature to start using these traffic cameras for real time detection.

AmberVision is the main product we will be delivering, but our project will also create a very unique dataset as a byproduct. Uber has started releasing some of its driver data (UberMove) , which contains GPS traces of their cars throughout New York City. AmberVision would essentially be collecting the same data using computer vision. We plan on storing the locations of all the cars we detect, at all timestamps, to keep a historical record of the visible traffic in the city. This would give very accurate historical traffic data, and could be used by DDOT or other researchers who are studying traffic in cities.

The last technical challenge will be translating our machine learning outputs into an intuitive and useful display for law enforcement. This tool will be a deployed web application that any law enforcement agency could log into and use. Translating the machine learning output to an easy to use interface will be challenging, but will be an extremely beneficial tool to all law enforcement agencies, and can be used in association with all sorts of crimes. AmberVision will help law enforcement deal with the swaths of information they are given to make quick decisions when time is of the essence. Investing in our product means investing in keeping our cities safe.

Suraj Shah

The AMBER Alert system is a messaging system that notifies the public of missing children and provides details about the abduction. This usually includes the car the victim was abducted in or the last article of clothing the victim wore. This model relies on text messages, which is the problem we want to extrapolate and improve upon. We believe that there is a definite purpose and target audience that will benefit from a significant improvement in the AMBER alert system including law enforcement agencies. As the trend continues to use technology to improve upon existing infrastructures and update outdated communication methods, we believe our product is innovative, usable, and beneficial as a tool for social good in the world. The goal we set ourselves to accomplish is to find a car, including details about the color, size, location, and timestamp information given a vicinity of traffic cameras in a city. Our purpose, as mentioned, is to provide a tool for the public good that can minimize the loss during emergencies and maximize the rate of finding victims (Kang, 2016). This realm of emergency situation detection has been addressed before, but no approach is currently been published to tackle amber alerts.

Our research and development phase has several steps, each of which will accomplish goals that bring us closer to the tool we will build. We will start by using the DDOT traffic camera data in Washington, DC. Since object detection has been a problem that many notable industries and researches have worked on, we believe using pre-existing models will help us identify a car in a traffic camera. However, we will have to face several technical difficulties including low-resolution cameras and the likelihood that a pre-existing model might not be completely transferable to the DDOT traffic camera network. Therefore, we will need to look into a combination of deep learning models such as YOLO (You Only Look Once) and Retinanet (Focal Loss Object Detection). Aside from the specifics of the models, we want to also collect our own data from a specific radius on the George Washington University campus. We want to limit our reliance on the DDOT traffic data so we will also look into other potential dataset collection methods. This includes setting up higher resolution cameras that can also provide more accurate information about the cars in the view. There will be technical difficulties with our data collection methods, especially with the dependency on the weather. We want to be able to collect data in which there are more objects in the cameras. This is based on weather, so there will be less in the view when it rains, snows, or becomes colder. To account for this challenge, we will combine the research and development phase of canned models with our own data collection. By combining these two parts, we will have adequate data to focus on the third part, the actual tool.

Regarding our key deliverable and our minimum viable product (MVP), we want to design a frontend website that has a 2D mapping of the filtered cars in the traffic camera radius with their last scene location on this map. This visualization will allow law enforcement to quickly find all cars related to a specific AMBER alert and allow them to focus on the important part, finding the victim. We believe this tool will be exceptionally useful, not only for this specific application but its overall multidisciplinary tool for society, which is why the funding is necessary to develop this idea into a product. In the end, our project would not be a proof of concept or an idea that has potential, but a full-fledged tool that can be used for various applications, not just for the AMBER Alert system.

**Similar Projects**

While researching the project, it is evident that there are similar projects and studies that have been conducted before regarding improving the current emergency alert system as a whole. One of the most notable research papers written on this topic is from Byungseok Kang with the paper *A Deep-Learning-Based Emergency Alert System*. This paper focuses on improving emergency alert systems using deep learning models and minimizing the loss of victims that occurs during these emergencies. This paper is a good start to the Amber Alert project, but it differs with regard to its goal. Whereas the goal of AmberVision is to solely focus on Amber Alerts, the deep learning model approach by Kang and their team is a holistic solution to a general problem. Therefore, our project differs from the emergency alert system project because our primary purpose is to improve the amber alert system. Furthermore, our project is different because Kang’s approach uses Convolutional Neural Networks whereas we are using transfer learning which is a different method to get more accurate results based on a variety of deep learning models, not just one single model.

The other project that exists that has similar ideas as the motivation for our project is a research paper written by Jason Kurniawan titled, *Traffic Congestion Detection: Learning from CCTV Monitoring Images Using Convolutional Neural Network*. This paper presents a novel approach to traffic congestion using computer vision models with traffic cameras. Although our project is not focusing on alleviating traffic in cities, we are using the concept of computer vision using CCTV data. Therefore, by understanding Kurniawan’s deep learning models and applying the principles to our own project, we are creating an entirely separate project that solves a different purpose.

The overall impact that our project has is its novelty as mentioned with the few examples that exist that have been published in this realm. It is evident that there is no current research paper or study done that uses traffic cameras to solve the focused goal of detecting cars in CCTV cameras based on Amber Alert data. However, it helps that there are projects that have used some machine learning and deep learning models on traffic cameras, because that can help us avoid potential problems and focus on the key successes of their projects. Need to elaborate more

**Target Audience**

We want to deliver a usable product at the end of this project. We aim to have a multidisciplinary tool that can be used by many, but our primary audience is law enforcement in this country and specifically for our pilot, the Washington DC police department. As the product goals allude, AmberVision is designed to help with active AMBER Alerts, but we see this tool being applicable to any number of crimes and could have larger reaching applications for police.

AmberVision would be extremely helpful to any member of law enforcement, and we hope to implement our system in every major city in America. We hope to deploy this technology nationally within large precincts and build out the network of cameras to enable large scale Amber Alert searching. Onboarding multiple police departments inherently improves the product because the data gathered is interoperable and can be used by multiple departments to aid and inform its own searches.

By working with established government bodies, AmberVision will use a licensing model which will charge per licensed user. This license needs to be renewed every year and will be specialized for each department user. The initial market is limited to law enforcement as we acknowledge the associated risk with our product and want to keep the product focused on its value proposition for Amber Alerts. The benefit of working with law enforcement is the level of network effect that exists within this industry; if one department finds the tool useful, then that customer story will drive other customers to our platform. Need to elaborate more

**Societal and global impact**

In a world of big data, we are not making full use of the information that we are collecting. Washington D.C. has hundreds of traffic cameras that are constantly collecting data, but none of this is being used. People are using big data for financial or statistical purposes, so why aren’t our law enforcement groups using the same sorts of strategies for cracking down on crime? We are building an application to bridge the gap between constant, usable information, and the people who can use this information to do the most good.According to the FBI’s National Crime Information Center (NCIC), there are over 400,000 entries for missing children. With AmberVision, we aim to continue lowering this number by helping enable robust searches through the network of cameras that exist on the road.

Transition.AmberVision will absolutely need regulation. Collecting people’s data unknowingly is always a slippery slope, so we are trying to make sure that our tool is not used by the wrong people. A member of a lab we all work in created a computer vision based application for law enforcement, which helped them to track down human trafficking victims using minimal images taken in hotel rooms. This tool could potentially be used by the traffickers to improve their techniques, but since it is firmly in the hands of law enforcement agencies, the technology is not being used for the wrong reasons. We will need to work with law enforcement to figure out the best way for this process to work.

TransitionAmberVision could potentially be used to track people in a city. Our tool is constantly creating a map of all of the visible cars in the city, which could help somebody malicious find out the whereabouts of anybody in the city. AmberVision can be interpreted as a “big brother” application, which is why we will take extensive measures to make sure this data is protected.

Missing people, but specifically children, go missing everywhere. This would be a problem if only one child was going missing, but sadly, thousands of kids are abducted every year, and many are never found. Any international city with traffic cameras throughout the city could use this technology. We cannot entirely solve this problem, since not all kids are taken in cars, but AmberVision will be able to at least start to combat this problem better than we have in the past.Explain how your product will work.

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