Enabling Live Video Analytics for Mobile Cameras

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Project Overview

With the growing use of networked video cameras, there is significant interest in live monitoring applications such as traffic surveillance, search-and-rescue, and disaster management. The key to success in effective live monitoring is leveraging a distributed set of cameras and deploying automated detection and analysis, a process known as video analytics (VA). Existing research has multiple limitations: it is largely limited to using stationary cameras and makes copious use of cloud computing for VA. Stationary cameras (as opposed to mobiles) limit the application space. Use of remote cloud computing can add delays, defeating the 'live'ness of applications.

To facilitate live applications, this project seeks to answer the following question: *"How can we perform live video analytics for mobile video streams?"* To this end, we focus on two advances: (i) integration of 'mobile' cameras into a video analytics framework, and (ii) enabling 'live' video analytics. See Figure 1. We leverage mobile cameras such as dashcams, drones, and smartphones, perhaps crowd-owned, in addition to more traditional stationary cameras. Mobile cameras expand the application space significantly as they are far more ubiquitous. However, 'live' VA for mobile cameras is an open-ended challenge given the unstable nature of wireless network connectivity due to camera mobility and resource limitation on the mobile cameras. We propose to exploit the emerging paradigm of *edge computing*, where compute resources closer to the cameras (such as set-top boxes, wireless access points/base stations) are used to reduce communication latency to enable live video processing. We envision a future where a *large ecosystem of cameras and live video analytics applications will be robustly supported by distributed and heterogeneous edge computing platforms.* This project takes the first important steps in this direction.

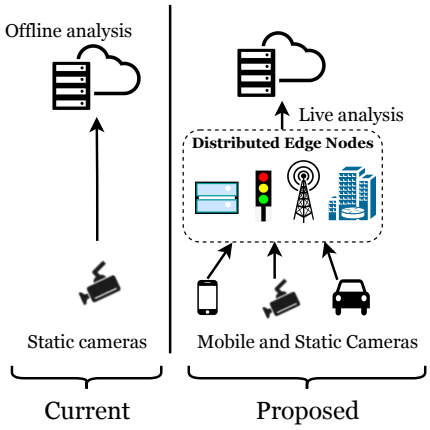

Figure 1: In contrast to existing static camera based offline video analytics, our VA framework integrates 'mobile' cameras with edge computing to enable 'live' video analytics.

Use of mobile cameras needs new technical innovations to support live VA. We must accommodate the mobility and the dynamic availability of crowd-owned cameras. To enable live processing, video streams captured from mobile cameras must be processed at compute nodes closer to the camera to reduce delays. Thus, the computation may need be relocated as the cameras move. On the other hand, the edge nodes are often heterogeneous and limited in terms of resources. Thus, the computation must also adapt.

To address these needs, we propose *Video Analytics Function Virtualization (VAFV)*, an adaptive framework for facilitating live VA for fixed as well as mobile cameras over heterogeneous edge nodes. VAFV is designed to be resilient to dynamic availability of the cameras and uncertainty in edge resource availability. VAFV achieves this by *breaking apart* the VA application pipelines into its constituent modules and deploying it over an overlay network of heterogeneous edge nodes. New video applications can now be rapidly deployed at scale by chaining existing modules on-demand in real-time, resulting in improved performance. Our work on this project will investigate the principles of such disaggregation and develop preliminary architectural and testbed design for VAFV in preparation for a larger proposal submission.