Demo Abstract: EVAPS: Edge Video Analysis for Public Safety

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***Abstract*—Real-time video analysis at the edge of the network is very promising to significantly improve public safety, e.g., dangerous accidents detection and find a missing person. Simply uploading the video stream to the cloud for analysis costs too much energy and network bandwidth to an energy-limited camera. Hence we propose EVAPS (Edge Video Analysis for Public Safety), which distributes the computing workload in both the edge nodes and the cloud in an optimized way. EVPAS is able to eliminate unnecessary data transmission over and save energy for edge devices, i.e., cameras. Three demos are used to illustrate the energy efficiency and optimized solution for public safety using the proposed EVAPS framework.**

***Keywords*-edge computing; video analysis; public safety;**

I. Problem Statement

Real-time video analysis, such as object detection, object tracking, face or text recognition, is important for public safety[1][2]. For example, the use of body-worn cameras can significantly improve public safety automatic detection and redaction of certain classes of entities[2]. The surrounding objects and incident will be captured and reported automatically using real-time video analysis enabled body-cameras. And also, the police can be alerted in a real-time manner when he or she encounters a dangerous person with criminal history, or when a shooting or fire event happens. In another potential scenario, real-time video streaming can be used in Emergency Medical Services (EMS) for training new paramedics or helping them handle low frequency high criticality conditions[3][4]. All of these scenarios require transmitting massive video data captured by cameras and cause heavy energy and bandwidth costs. However, most kind of cameras (for example, body-worn cameras, smartphone cameras, city cameras and car recorders) are typically designed with restrained energy resources, especially body-worn cameras and mobile devices. Hence, in real-time video analysis for public safety, it is critical to reduce energy consumption and transmission volume on energy-limited cameras.

Edge video analysis is the key to solve the problems stated above. In edge computing, computing should happen at the proximity of data sources[5]. One remarkable feature of real-time video analysis proposed here is that the processed video is much smaller than the source raw video in term of size yet without missing any significant object and event, especially after a face detection or other recognition processing[6]. For example, in the EMS field, a mobile app which records a video of an electrocardiogram (ECG), can delete the useless areas in a video to minimize data transmission without compromising the ECG recognition on the receiving end. And to find a missing person in the AMBER alert system, the police can send the kidnappers vehicle license plate to all the camera-connected edge nodes connected in a cloud, including city and body-worn cameras. The edge nodes start to process the recognition model and automatically recognize vehicle license plates in videos. When an edge node discovers the matching plate, it will report the target and send a video clip to the law enforcement. By performing video analysis on edge nodes vs a centralized server, data transmission can be minimized. Finally, edge video analysis can improve the data transmission reliability and quality in the situation of network instability. When the network is unstable, edge nodes can store the data locally and transmit once the network is recovered.

In this poster, we propose Edge Video Analysis for Public Safety (EVAPS) framework for real-time video analysis to improve public safety. We briefly describe our approach, and demo setup.

II. Our Approach

In our proposed EVAPS framework, as shown in Fig. 1, computing workload is distributed between edge nodes

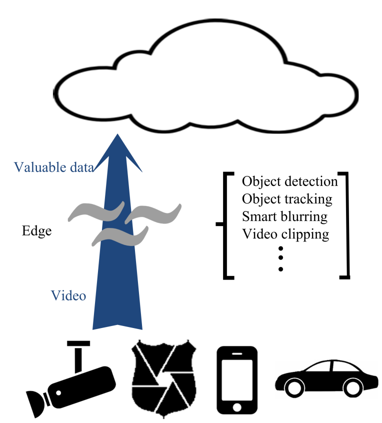

Figure 1. An overview of edge video analysis.

and the cloud to reduce the demand for bandwidth and computing capacity. Conventionally cameras capture videos and send them to the cloud directly. When edge nodes are deployed along the path between cameras and the cloud, as intimidates they receive video data and perform real-time analysis such as object detection, object tracking, smart blurring and video clipping. Finally, valuable information in video data will be extracted and sent to the cloud for further analysis. The extraction process effectively reduces the video size and therefore the transmission cost. On the other hand, the cloud can determine what kind of video analysis to be performed on edge nodes as mentioned in [5]. Besides that, the cloud can request edge nodes for extra work, such as finding a particular object. As soon as the target is found by one of the edge nodes, it will reply and send some proofs to the cloud, such as pictures or video clips. Certainly data will be stored locally in edge nodes and transmitted to the cloud when network is as stable as required.

To implement an EVAPS prototype, smartphones, Raspberry Pi, body-worn devices and laptops work as edge nodes, a desktop PC plays the role of the cloud, and OpenCV is chosen as a video analysis tool from some popular computer vision libraries[6]. In our approach, the edge nodes receive raw video data from cameras, perform part of the video analysis like face detection before sending the post processed video to the cloud for further analysis. Finally, the result of video analysis will be returned to the edge node and an alert will be raised if a persons face with criminal history is recognized. Besides that, the cloud can remotely invoke operations on an edge node via a RPC (Remote Procedure Call). For example, in the AMBER alert system, the cloud can request all edge nodes to recognize the vehicle license plates in the video to find the kidnappers vehicle.

III. Demo Setup

In this section, we will use three demo applications to demonstrate how EVAPS can effectively balance computing and communication cost in various scenarios by implementing different strategies.

In the first demo, we implement a face detection model using OpenCV on edge nodes, including smartphone, Raspberry Pi, and body-worn cameras, and face recognition on a desktop PC as the cloud. Edge nodes obtain face pictures from video data and send them to the cloud. While the persons face with criminal history is recognized in the cloud, an alert will be sent to the edge node which sent the picture. We also set up a comparative experiment, where the cloud is responsible for all computing tasks. Without any edge node as an intermediate, the cloud receives video streaming directly from cameras and performs face detection and recognition using OpenCV. When the object is recognized and matches a recorded criminal history, the cloud will send the alert to edge nodes.

In the second demo, as shown in Fig. 2, we implement a mobile application for EMS. With this app, the medical staff in the hospital can see the live video about vital signs remotely. In a video, only useful information is filtered by edge nodes and sent to the cloud, such as images about ECG, sphygmomanometer and human body, even the values on monitors. In the comparative experiment, the source video data is directly uploaded to the cloud.

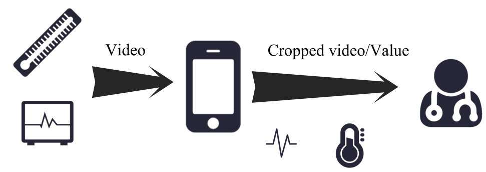

Figure 2. Demo setup for EMS using EVAPS.

In the third demo, we use EVAPS to improve the AMBER alert system. While edge nodes receive an alert from AMBER, edge nodes like body-worn cameras and city cameras deployed nearby where the incident happened will automatically search for vehicle license plates in videos for a match for the kidnappers vehicle. Once found, it will report the location information and related video clips. In the comparative experiment, cameras upload the source video data and all the video analysis will be processed on the cloud.

In EVAPS, video is transmitted between cameras (edge nodes) and the cloud in the form of clips other than the original one, which helps significantly reduce the amount of data and energy when transmitting. Although it consumes more computing energy at cameras side, an optimal strategy will be selected for different scenarios as a tradeoff between computing and communication costs.

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