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Media Upload Prioritization Based on User Preferences

Yu-sheng Chen

Connor McKeon

Ella Mihov

Matt Wagner

Fish Lin

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ABSTRACT

Poor wireless network conditions limit the ability of security cameras and other devices to upload media. Consequently, viewers may not be able to watch video streams in a timely manner. On the other hand, even successfully uploaded media available for viewing is sometimes found to not be of interest to the user. This disclosure describes techniques to determine media segments (e.g., live video captured by a camera) likely of greatest interest to viewers and prioritize the uploading of those segments. The criteria for uploading or storing media under poor network conditions are selected to optimize the user experience on a best-effort basis. When network connectivity is limited, uploaded segments (and the order of uploading) match the current interests of the users. When device storage is full, segments to be discarded (and the order of discarding) are of least interest to the user. The described techniques of prioritized media upload and retry/discard strategies optimize user experience under poor network conditions such as frequent network outage, low available bandwidth, unstable network connection, etc.

KEYWORDS

- Media upload
- Prioritized upload
- Prioritized storage
- Adaptive prioritization
- Smart home network

BACKGROUND

Security cameras are becoming commonplace in home security and other settings. Poor wireless network conditions limit the ability of security cameras and other devices to upload media. Consequently, viewers may not be able to watch video streams in a timely manner. On the other hand, even successfully uploaded media available for viewing is sometimes found to not be of interest to the user.

Upon a network outage, security cameras store recorded media in a local disk. Upon network recovery, both the stored media and the incoming livestream need to be uploaded, which may be beyond the available network capacity. In such circumstances, a portion of the stored recorded media may need to be discarded when the local storage is full (e.g., available storage falls below a threshold) to ensure that the device can continue to function properly.

Some current strategies to address the problem of uploading or storing media under poor network conditions include:

- **Most recent first:** The device uploads media in the order of most recent to the oldest such that the most recently captured media is first uploaded, followed by the second most recent media, and so on until the oldest media is uploaded. If the device storage is full, the oldest media segment is discarded first, followed by the second oldest segment and so on until sufficient storage is available. The most-recent-first technique implicitly assumes that the most recent data is the most meaningful to the user, an assumption not borne out by experience. For example, meaningful events in the context of a security camera can be a vehicle or person passing by, a door opening or closing, a package being left in the porch, etc., none of which is correlated with recency.

- **Throttling:** The media quality is throttled to match network availability of bandwidth. Recording is paused (or the duration of recordings reduced) when storage is full. Recording restarts when the network recovers. Throttling doesn't make good use of local storage since the reduction of duration or quality might be unnecessary if local storage can accommodate short-term network loss. Pausing recording can result in the loss of important moments of the video or audio. Even with full storage, the camera can potentially record and transmit interesting media while discarding uninteresting media.
- **Arbitrary segments:** Arbitrary segments of the recorded media are selected to be uploaded first. When the storage is full, the device discards segments in an arbitrary order until sufficient storage is freed up. Selecting arbitrary segments to upload or delete does not account for the likely importance of a segment prior to it being uploaded or deleted.

None of the above techniques for selective uploading and deletion of local media under poor network conditions account for the relative importance of segments of the media or optimize user experience.

DESCRIPTION

This disclosure describes techniques to determine media segments (e.g., live media captured by a camera such as audio, video, and/or images) that are likely of greatest interest to viewers and prioritize the uploading of those segments. Specifically, if the network bandwidth is only sufficient to enable the uploading of part of the media, the order in which various live-captured media segments (e.g., thumbnails, snapshots, video clips, etc.) are to be uploaded is determined. If the local storage is full, the order in which media segments are to be discarded is determined. The described techniques of prioritized media upload and retry/discard strategies

optimize user experience under poor network conditions such as frequent network outage, low available bandwidth, unstable network connection, etc.

Unified media prioritization

For the purposes of upload or storage, a piece of media is assigned a priority based on criteria that include:

- *Eventfulness*, which captures whether or not the media is associated with an event or notification that the user has signed up for. Eventful media is more important than eventless media.
- *Liveness*, which measures the age of the recorded media, computed as current timestamp minus the recorded timestamp. The priority of a media is determined based on recency.
- *Media type*, e.g., video, audio, snapshot (still image), thumbnail, etc. A thumbnail can include one or more still images or a low resolution and low frame rate video (e.g., similar to an animation) Being lightweight, thumbnails are accorded a higher likelihood to be uploaded in poor network situations, and are usually the first, representative media that users see. Similarly, audio, with its relatively small size, is accorded a higher chance to be uploaded in poor network situations. However, in many applications involving livestream, video may be more valued than audio.

Applying the above criteria, media content can be initially prioritized as in Table 1. The relative priority of different types of media content can be manually customized by the user or automatically adjusted by user interaction analytics (such as event types most watched or clicked upon by the user, event types valued by the user base, etc.), performed with specific user permission. The prioritization can adaptively match user interests and can be adjusted over time as user interests change.

Priority (descending order)	Media	Typical size
1	Live snapshot	100-200 kB
2	Eventful snapshots from latest to oldest	100-200 kB
3	Eventful video and audio from latest to oldest	2-3 MB
4	Non-eventful video and audio from latest to oldest	2-3 MB

Table 1: Priorities for various types of media content

Media upload/retry

A newly created segment of media that is available for upload is assigned a priority and added to a pool of locally stored media. Media segments are uploaded in descending order of priority. Segments that failed to upload are re-included in the pool for retrying. A media segment confirmed as successfully uploaded is removed from the pool.

Media storage/discard

As long as local storage space is available, segments/clips that fail to upload are persisted in storage. When local storage reaches its limit, media segments are discarded in ascending order of priority until available storage exceeds a predefined limit.

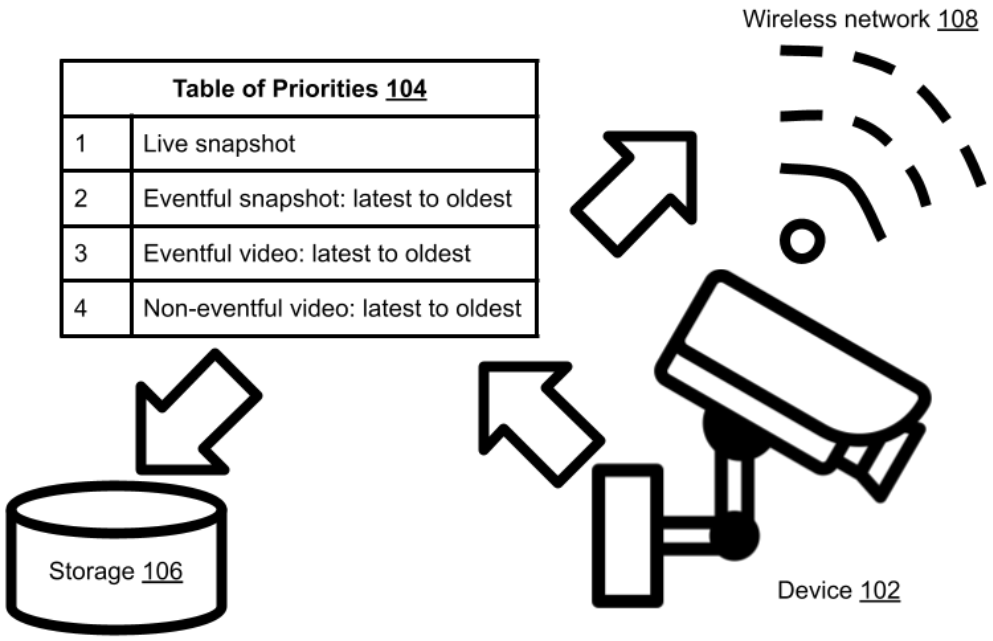

Fig. 1: Media upload driven by user experience

Fig. 1 summarizes media upload driven by user experience. When network conditions (108) are poor, a table of priorities (104) is utilized by an uploading device (102) such as a security camera to make decisions to transmit (upload) media in descending order of priority and to store the media in storage (106) in ascending order of priority.

Generalization to smart home networks

The described techniques of prioritized upload, storage, and retry ensure that media likely of greatest value to the user have a best-effort, optimized survivorship under poor network conditions. The techniques can also apply to external storage available to a camera or other uploading device. For example, in a smart home network, which can include a networked collection of devices such as smart TVs, smart displays, smart cameras, smart speakers, IoT devices, routers, etc. the uploading devices can leverage common storage (e.g., mesh storage) available to devices on the home network. Each uploading device in the home network can

offload their media to a common storage within the home network even as media uploads are tried/retried based on priority order. The pool of media segments on the common network storage can be subjected to prioritized discarding based on the total available storage in the network.

The described techniques are applicable generally to devices that upload media, e.g., security cameras, smart doorbells, smart displays, monitoring systems with recording capability with or without external, internal, or remote storage. Media uploads are performed in accordance with user settings in a secure manner and in compliance with applicable regulations. The user is provided options to control media uploads as well as adjust media prioritization strategies.

The described techniques for uploading or storing media under poor network conditions optimize user experience on a best-effort basis. When network connectivity is limited, e.g., uptime or usable bandwidth is low, uploaded segments (and the order of uploading) match the likely interest of the users. When device storage is full, segments to be discarded (and the order of discarding) are likely of least interest to the user.

Further to the descriptions above, a user may be provided with controls allowing the user to make an election as to both if and when systems, programs or features described herein may enable collection of user information (e.g., information about a user's activity viewing uploaded media such as audio/video/thumbnails, a user's smart home devices, social network, social actions or activities, profession, a user's preferences, or a user's current location), and if the user is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user's identity may be treated so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location

information is obtained (such as to a city, ZIP code, or state level), so that a particular location of a user cannot be determined. Thus, the user may have control over what information is collected about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This disclosure describes techniques to determine media segments (e.g., live video captured by a camera) likely of greatest interest to viewers and prioritize the uploading of those segments. The criteria for uploading or storing media under poor network conditions are selected to optimize the user experience on a best-effort basis. When network connectivity is limited, uploaded segments (and the order of uploading) match the current interests of the users. When device storage is full, segments to be discarded (and the order of discarding) are of least interest to the user. The described techniques of prioritized media upload and retry/discard strategies optimize user experience under poor network conditions such as frequent network outage, low available bandwidth, unstable network connection, etc.

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