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Adaptive Notification Delivery for Home Camera Feeds

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Adaptive Notification Delivery for Home Camera Feeds

ABSTRACT

Home security cameras generate notifications related to motion detection, person detection, person recognition, etc. when an event and/or person is detected within the camera feed. Detecting motion, attributing it to the presence of a person, and identifying the person require progressively greater amounts of time, and can lead to separate notifications in quick succession. Such notifications interrupt and burden users and can cause them to miss or ignore relevant ones. This disclosure describes techniques that reduce notification volume by introducing user-configurable cascading delays in delivering notifications to provide time for person recognition. For persons who are recognized, users receive a single optional notification while other notifications are suppressed. The techniques provide contextually appropriate and user-configurable suppression of notifications from home camera feeds without introducing an unreasonable delay in notification delivery. Notifications of relevance and value continue to be delivered, and with suppression of other notifications, can be more prominent.

KEYWORDS

- Home security
- Security camera
- Motion detection
- Person detection
- Face recognition
- Familiar face
- Notification suppression
- Delayed notification delivery

BACKGROUND

Home security setups now often include security cameras inside and outside homes. Such cameras can be standalone security cameras or those embedded within other devices, such as smart doorbells, smart thermostats, smart speakers, smart home hubs, etc. Many cameras are equipped with capabilities to analyze the camera feed to sense for specific events (e.g., motion) and/or specific people (e.g., residents of the home). Users can choose to receive notifications on their mobile devices when an event and/or person is detected within a camera feed.

The notifications are typically sent out immediately when the corresponding event or person is detected within the camera feed. However, detecting motion, attributing the detected motion to a person, and identifying the person based on face recognition takes progressively longer amounts of time because of progressively greater computational complexity. Moreover, the distances from the camera at which motion, persons, and faces can be accurately detected are progressively smaller because of the need for progressively greater detail within the camera feed for the respective detection. For example, the presence of humans within the feeds of typical cameras deployed inside and outside homes can be detected as far away as 20-30 meters from the camera. On the other hand, identifying human faces requires the person to be much closer to the camera (i.e., within 3-5 meters). Presence of a person within the camera feed can often therefore be detected much sooner than the time it typically takes the person to move close enough to the camera for the face recognition to begin.

As a result, the same activity may cause several notifications to be generated in quick succession. For instance, a resident of the home walking toward the camera can lead to the detection of motion when the person is far away, followed by the motion being attributed to a person and finally by the person being recognized as a familiar face as the person moves

progressively closer to the camera. While it is possible to withhold the notifications of earlier detections of motion and person detection until the person is identified, such an approach can introduce a security risk because of the delay in receiving a notification of potential undesirable activity from unwanted persons.

Camera feed notifications are generated even for a user's own activity resulting in the user receiving notifications whenever approaching any camera that triggers such notifications. Some cameras or devices permit a user to suppress notifications for specific individuals (e.g., self, other members of the household, frequent visitors). However, the feature requires the identification based on face recognition to occur within a preset static time interval that the user cannot modify. If identification takes longer than the preset threshold, the user ends up receiving the unwanted notifications. Moreover, the feature does not take into account whether a user is already present at home which can create a security risk if the face recognition is inaccurate. For instance, a false negative in face recognition (erroneously detecting a person to be a known person) can lead to incorrectly suppressing notifications.

Receiving too many unwanted notifications regarding activity in the camera feed inside and outside the home results in interrupting and burdening users with unnecessary information. A large number of undesired notifications can lead users to miss or ignore notifications that are of interest and importance.

DESCRIPTION

This disclosure describes techniques that reduce the volume of notifications a user receives from the activity detected from various camera feeds deployed inside and outside the user's home. The reduction in volume is achieved by introducing a user-configurable delay in delivering initially-generated notifications about detected human activity. The delay can allow

sufficient time for the face recognition operation to be completed. If a person is recognized via face recognition, notifications about motion and person detection regarding that individual are suppressed resulting in the user receiving a single notification based on the face recognition.

When away from home, a user may still want to know about familiar persons inside or outside the home to mitigate unforeseen risks and/or remotely verify expected presence and activity. However, when at home, users are unlikely to want to be notified about known, trusted individuals (including themselves) being present inside or outside the home. Therefore, with user permission, notification volume can be further reduced by suppressing camera feed notifications about people familiar to the user whenever the user is detected with permission to be present at home. Users can be provided the ability to specify the identities of familiar individuals about whom notifications can be suppressed when the user is at home. Additionally, the user may turn off notifications for specific portions of the home (e.g., floors or sections) or the entire home when they are at home.

In addition, users can define specific activity zone(s) of interest within the camera view. If users permit , notifications can be limited to any human activity captured within the camera feed that occurs within the specified activity zone(s). Such an approach can avoid delivering notifications about irrelevant activity, thereby cutting further down on unwanted notifications users receive. For instance, an activity zone drawn around the driveway of the home can prevent notifications about a person across the street until the person crosses into the driveway. For cameras that have activity zones defined, the delay in delivering the initially-generated notifications can begin upon initial activity detection within the activity zone. Users can select what gets suppressed such that they can receive, e.g., no notifications about recognized users, notifications about some recognized users, but not others, etc.

The delays are used in a cascading manner whenever motion is detected within the camera feed (or specified activity zone(s) within the camera feed, if defined). For instance, a notification about the detected motion is suppressed if a person is subsequently detected within X seconds. In turn, the person-detection notification is suppressed if the person is subsequently identified via face recognition within Y seconds after being detected. Any activity for which the subsequent detection does not occur within the specified interval results in the notification for that activity being delivered at the end of the interval. For instance, if no person is detected within X seconds after sensing motion, the user is notified about the motion. Similarly, if the person's face is not recognized within Y seconds after the person is detected, the user receives the person-detection notification. The cascading approach is intuitive since it mimics the logic used for grouping multiple notifications about the same event based on a time window.

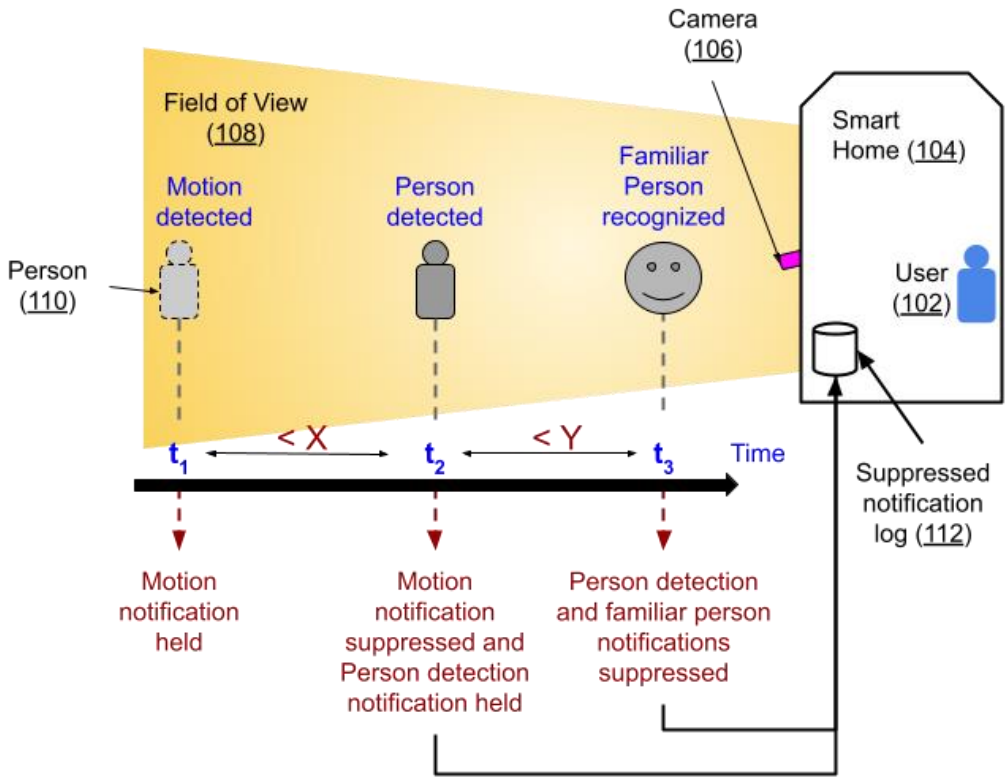

Fig. 1: Delaying and suppressing notifications

Fig. 1 shows an example operational implementation of the techniques described in this disclosure. A user (102) is present at home (104). A person (110) walks into the field of view (108) of a camera (106) on the outside of the smart home. As the person approaches the home and moves closer to the camera over time, motion is sensed at time t_1, the motion is detected to be of a person at time t_2, and the person is recognized as someone familiar to the user at time t_3. The notifications about the motion detection generated at time t_1 is withheld until a person is detected at time t_2. Since the interval between t_1 and t_2 is less than the pre-specified delay X, the motion notification is suppressed and recorded in a log database (112). Similarly, the notification about the person detection generated at time t_2 is withheld until the person is recognized at time t_3. Since the interval between t_2 and t_3 is less than the pre-specified delay Y, the motion notification is suppressed and logged. Since the person is familiar to the user and the user is at home, the notification about the familiar person being detected is also suppressed and logged.

The delays X and Y used for the initially-generated notifications can be set by the developers and/or specified by the users. Higher values of X and Y can permit greater time for analyzing the camera feed to detect events and persons to facilitate larger reductions in notification volume but introduce a larger delay between the detection of the first activity and notification delivery. On the other hand, shorter delays can deliver notifications faster after detecting the first activity but can sometimes result in unwanted notification delivery because the subsequent detection could not be completed within the specified interval. Typically, delays of 5-10 seconds can be sufficient to permit person detection and face recognition to complete in a majority of cases without the notifications being noticeably delayed.

To avoid confusion, when a user is detected to be at home, notifications about a familiar person being detected can be suppressed even if the face recognition process is completed after

the specified delay. In other words, a user at home would not receive notifications about familiar persons being detected even if prior notifications about motion and/or person detection regarding the individual were delivered because of timing out while waiting for the subsequent detection. In contrast, notifications about detecting unfamiliar faces can be delivered immediately without suppressing regardless of whether the user is detected to be home. Limiting suppression to notifications about familiar persons while the user is at home can avoid the potential security risks of delayed notifications and false positives in face recognition (unfamiliar persons deemed to be familiar).

With user permission, any notifications that are suppressed can be stored in a user accessible log along with relevant metadata, such as session ID, camera ID, timestamp, etc. Users can examine the logs to view the camera feed recording snippets of the activity corresponding to the suppressed notification. In addition, users can verify whether the notification suppression was appropriate and provide \feedback about the accuracy of the suppression or change configuration settings.

The techniques described in this disclosure can be used with any indoor or outdoor cameras or camera-equipped devices that provide the capability to analyze the camera feed for activity of interest. Detection of activity within the camera feed can be performed via any standard off-the-shelf techniques employed for specific purposes, such as motion detection, person detection, face recognition, etc. Similarly, if timeouts result in multiple notifications being generated about an activity, the notifications can be updated and consolidated as part of the same activity by employing standard mechanisms for notification grouping.

Implementation of the techniques can result in contextually appropriate and user-configurable suppression of a subset of notifications (that are likely to not be useful) from home

camera feeds without introducing an unreasonable delay in notification delivery. The reduction in the volume of notifications from home camera feeds can enhance the user experience (UX) by avoiding unnecessary interruptions and reducing the risk of users missing relevant notifications. Notifications of relevance and value continue to be delivered, and with suppression of other notifications, can be more prominent.

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 security cameras, a user's home, camera settings, notification preferences, a user's contacts, 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 that reduce notification volume by introducing user-configurable cascading delays in delivering notifications to provide time for person recognition. For persons who are recognized, users receive a single optional notification while other notifications are suppressed. The techniques provide contextually appropriate and user-configurable suppression of notifications from home camera feeds without introducing an

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