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Turning off or dimming a device screen based on user attention

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ABSTRACT

Device screens are often set to turn off and/or dim automatically if no user interaction is detected for a specified amount of time. Turning off or dimming the screen saves power and prolongs the amount of time the device can operate without needing to recharge the battery. However, such timeout-based actions can result in false positives or negatives. With user permission, this disclosure utilizes contextual input of a user's gaze and attention for management of the automatic turn off or dimming of the device screen. The techniques are applied to reduce the false positives and negatives and ensure that the screen stays on longer if the user is still engaged with the device and turns off or dims before the timeout if the user has stopped using the screen.

KEYWORDS

- screen turn-off
- screen dimming
- gaze detection
- user attention
- Always On Display (AOD)
- power management
- battery life
- machine learning

BACKGROUND

Screens of devices such as smartphones, tablets, laptops, etc., are often set to turn off automatically if no user interaction is detected for a specified amount of time. Turning off the display saves power and prolongs the amount of time the device can operate without needing to recharge the device battery. However, such timeout-based automatic display turn off can result in false positives or negatives.

For instance, the lack of user interaction could be due to the user being occupied with another task temporarily or being focused on reading on-screen material without needing to interact with the screen. In such cases, when a timeout occurs, the device screen turns off even when the user is looking at the screen. In contrast, there are situations where it is clear that the user has stopped viewing the screen, e.g., when the user leaves a device on a table or desk or places it in the pocket, and yet, the screen stays on until the timeout occurs unless the user explicitly turns it off prior to disengaging. In such cases, the screen staying on wastes power. Similar considerations apply when the screen is dimmed upon timeout instead of being switched off completely.

Some devices include a low-power Always On Display (AOD) to provide frequently needed functions, such as clock, notifications, etc. To keep the AOD power requirements low, the AOD supports a limited set of features which lack common capabilities, such as interactive controls and saved state information. As a result, the features available via the AOD can feel less responsive to user input and may show stale data.

DESCRIPTION

With user permission, this disclosure utilizes contextual input of a user's gaze and attention for management of the automatic turn off or dimming of the device screen. The techniques are applied to reduce the false positives and negatives and ensure that the screen stays on longer if the user is still engaged with the device and turns off or dims before the timeout if the user has stopped using the screen.

To optimize the automatic screen turn off or dimming functionality, the user-facing camera of the device is utilized, with the user's permission. If the user permits, input from the camera is passed to a trained machine learning classifier. The output of the classifier indicates whether the user's gaze is currently on the screen, thus indicating ongoing attention. When the user permits, additional contextual information is combined with the gaze detection feature to infer high level attention patterns of the user's engagement. For instance, if the user briefly glances away from the device to attend to another task and then switches to looking at the device again, the situation is still considered as the user paying attention to the device. The determined attention to the screen (or lack thereof) is utilized to turn off or dim the screen as soon as the user stops engaging with the device or to keep the screen turned on beyond the timeout as long as the user is still looking at the screen.

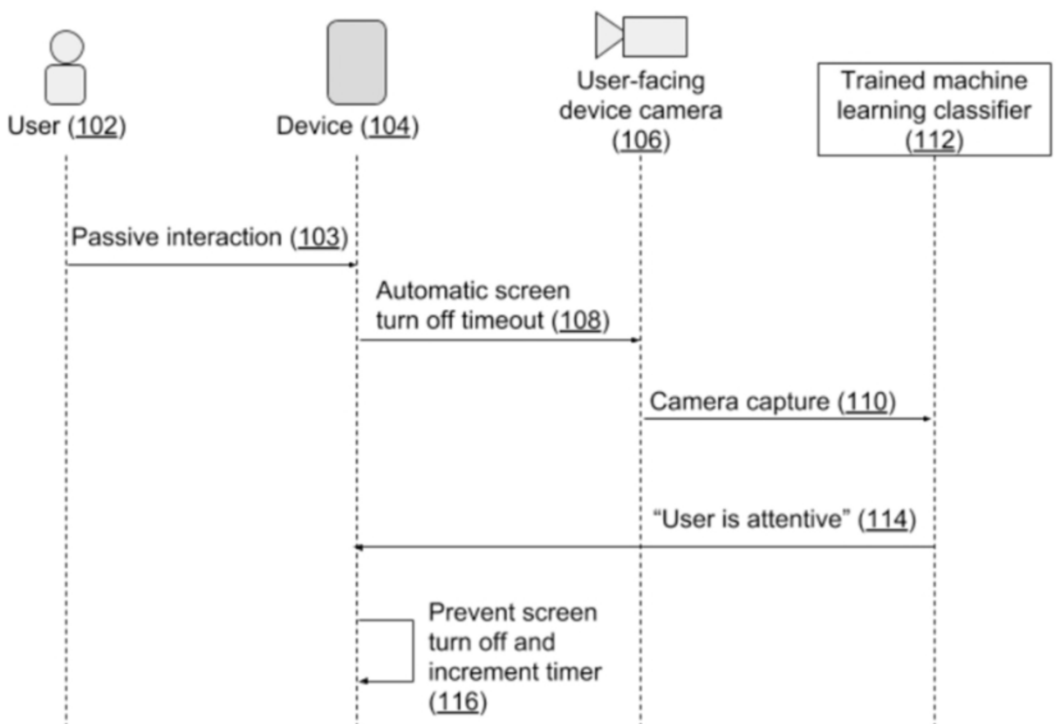

Fig. 1: Managing device screen turn off or dimming based on user attention

Fig. 1 shows an operational implementation of the techniques described herein. A user (102) is interacting passively (103) with a device (104) that includes a user-facing camera (106). As a result of the passive interaction without any explicit action from the user, the timeout for automatic screen turn off (108) is triggered. Prior to turning the screen off, the user-facing camera is activated. The image or video captured by the camera (110) is sent as the input to a trained machine learning classifier (112).

The output of the classifier (114) indicates whether the user's gaze is still on the screen, thus indicating whether the user is attentively engaged with the device. If the user is inferred to be attentive, automatic screen turn off is prevented from occurring and the corresponding timer is incremented (116) to delay the automatic screen turn off. The process repeats when the incremented timer expires.

The same operation can be applied to support user-attention-based screen dimming instead of, or in addition to, screen turn off. If the user permits, additional contextual information, such as input captured by device sensors and/or other user data can be used as additional inputs to the classifier.

If the user permits, the operation depicted in Fig. 1 can be extended to include explicit checks for user's attentiveness even when the timeout of automatic screen turn off is yet to occur. Upon permission from the user, such checks can be initiated based on external triggers such as: a timer shorter than the automatic screen turn off timeout; detecting the device to be placed in the pocket based on information from the device sensors; detecting the phone to be placed on a surface, such as a table or desk, based on information from the device sensors; etc. If the checks indicate that the user is not paying attention to the device, the screen can be turned off or dimmed.

If the user permits, the attention checks for dimming or brightening the display can be performed more frequently than those for turning the screen off, since brightness changes are quicker. More frequent checks can reduce latency for switching to the lower power dimmed mode as well as for switching back to the full power bright mode. This allows the screen to become brighter as soon as the user starts looking at the device after a period of disengagement.

To detect re-engagement with the device after a period of non-attentiveness, the user-facing camera and/or the device sensors can be used to detect the user's attention, proximity, etc. For instance, an accelerometer reading can detect that the user picked up the device, and the user-facing camera can indicate that the user has started looking at the screen.

The explicit checks for user's attention can also be extended to the AOD if permitted by the user. When the AOD is active, frequent attention checks can cause the device battery to drain. Therefore, when the AOD is active, triggers based on proximity or accelerometer may be preferred to detect if the user is close to the device and has picked it up to engage with the AOD. If the user is detected to be paying attention, the AOD features are enhanced to allow direct user actions, such as controlling media, refreshing the information available on the AOD, highlighting urgent notifications, etc. For example, the AOD can be refreshed to show "What's Playing." Such enhancements to the AOD avoid the need for the user to unlock and/or interact actively with the device, which improves the user experience and can save battery. With the user's permission, such functionality can be combined with other device features, such as sensor-based authentication to ensure that the user is authorized to view and control the AOD.

The techniques of this disclosure can be utilized in any capable device regardless of whether the device is portable or utilizes battery power. For instance, the techniques can be utilized in devices such as smartphones, tablets, smartwatches and other wearable devices, televisions, laptops, desktops, etc. Timers and triggers incorporated in the operation of the techniques can be specified by the device operating system, device manufacturer, or by the user. Alternatively, if the user permits determination of context using permitted user data, the timers and triggers can be set dynamically as appropriate to the user's context.

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 (e.g., a device that implements user attention based management of screen and the associated software code, e.g., operating system or other software) described herein may enable collection of user information (e.g., information about a user's 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

With user permission, this disclosure utilizes contextual input of a user's gaze and attention for management of the automatic turn off or dimming of the device screen. The techniques are applied to reduce the false positives and negatives and ensure that the screen stays on longer if the user is still engaged with the device and turns off or dims before the timeout if the user has stopped using the screen. Explicit attention checks carried out with the user's permission can also be extended for always-on displays to enhance always-on displays to enable direct user actions or refresh the information provided on the always-on display.