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# Content aware user interface retargeting

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ABSTRACT

This disclosure describes the preservation of important elements of a user interface (UI) during retargeting of the interface image on a mobile device. An on-device machine learned (ML) model is utilized to detect saliency or lack thereof of various UI elements in the user interface. Training of the ML model is performed by utilizing training data from repositories of software application designs and screenshot data from online marketplaces and app evaluation services.

The trained ML model is utilized to detect salient UI elements that are to be preserved during display retargeting. During resizing of the UI, with express user permission, content-aware image retargeting techniques are utilized for the preservation of elements identified as important by the UI saliency detection model. Past interactions are utilized, and interpretation or corrective action is performed only upon permission from the user.

KEYWORDS

- One-handed mode
- User interface
- Image retargeting
- Content-aware retargeting
- UI saliency
- Smartphone UI

## BACKGROUND

Large form factor mobile devices, such as phones or tablets with large screens, can be cumbersome to use with one hand. A one-handed mode is available for such devices. In such a

mode, the screen content is rescaled to enable use with one hand, e.g., scaled down and shifted towards a corner of the display. This can be useful in certain situations where only one-handed operation is possible, e.g., a user who is engaged in activities such as eating, reading, holding oneself steady with one hand when traveling by public transport, etc. In one-handed mode, an active UI on the screen is scaled down and displayed such that elements in the UI are reachable with one hand. Typically, such reduction in size is performed without taking into account specific content on the screen which negatively affects user experience, e.g., if a scaled-down UI is illegible as displayed or makes touch operations more error prone, etc.

## DESCRIPTION

This disclosure describes the preservation of size of salient elements of a user interface (UI) during display resizing by using image retargeting techniques for salient elements of the user interface. Techniques described herein utilize an on-device machine learned (ML) model for user interface element saliency detection.

Content aware image retargeting is utilized to intelligently resize user device screen content while taking UI element saliency into account. Preservation of important UI elements during resizing provides a better user experience in modes such as the one-handed mode.

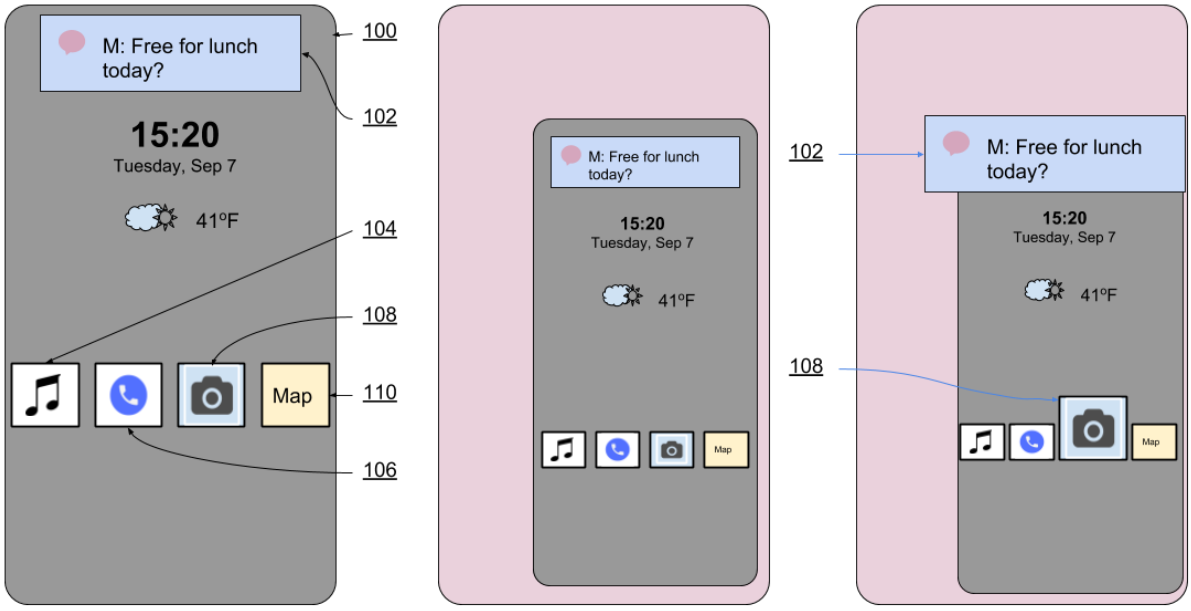


**Fig. 1: Important user interface elements are preserved during screen resizing**

Fig. 1 illustrates screen resizing in one-handed mode. Fig. 1(a) depicts a user interface displayed on the screen of a mobile device (100) in normal (non-scaled, full-screen) mode. In this illustrative example, the screen includes a message window (102), and icons representing different applications (104, 106, 108, and 110).

Fig. 1(b) depicts the user interface on the device screen with the device in one-handed mode. As seen in the figure, the active display portion of the screen is resized to a smaller area, allowing for easier user access to all portions of the active display area. However, all screen elements such as the message window and app icons are resized using a similar ratio. This is per current techniques of simply resizing the entire user interface without regard to saliency of individual elements in the user interface.

Fig. 1(c) depicts the resized user interface displayed on the device screen, utilizing the techniques of this disclosure. As seen in the figure, the size of certain UI elements is preserved during the resizing of the active display area by use of image retargeting techniques. In this

illustrative example, the size of the messaging window (102) and the camera icon (108) is preserved while the rest of the user interface is resized. Preservation of the size of the messaging window and camera icon improves the readability of text content and enables the user to more readily access the camera icon. Determination of the saliency of the elements is performed with specific user permission, and the techniques of retargeting are not implemented if a user denies such permission. Permission may be obtained at an initial setup time, and is modifiable at any time by the user.

An on-device ML model is utilized to detect or segment salient elements in the user interface, such as titles, important actionable buttons, click targets, swipes, etc. The ML model can utilize any standard image classification or segmentation technique such as, e.g., single-shot multibox detection (SSD), inception, visual geometry group (VGG), resnet, mobilenet, etc. The techniques are typically based on a convolutional neural network architecture.

Training of the ML model is performed by utilizing different sources of training data such as open annotated repositories of mobile app designs, data (e.g., screenshots) from app developers or online marketplaces that sell software applications, and data from app evaluation services that run, analyze, and collect data such as screenshots and UI view hierarchy, etc. In addition to raw screenshot data, the model can utilize view hierarchy data, e.g., to identify buttons, text input fields, etc. The trained ML model can be utilized to predict important and salient UI elements that are to be preserved (not resized) when other portions of the UI are resized.

Content-aware image retargeting algorithms such as nonhomogeneous warping (Warp), seam-carving, scale-and-stretch, multi-operator (Multiop), shift-maps, etc. are utilized for the resizing of elements. The algorithms are utilized to preserve the size of elements that are

identified as important by the UI saliency detection model. During the resizing of the active display of the screen, output from the UI saliency detection model that identifies salient element UI elements is utilized to preserve the extent and presence of such UI elements.

The described techniques can be implemented, e.g., as part of an operating system for devices such as smartphones, tablets, etc. Manufacturers of such devices may also integrate the techniques, e.g., in their customization of the operating system and user interface.

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 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 the preservation of important elements of a user interface (UI) during retargeting of the interface image on a mobile device. An on-device machine learned (ML) model is utilized to detect saliency or lack thereof of various UI elements in the user interface. Training of the ML model is performed by utilizing training data from repositories of

software application designs and screenshot data from online marketplaces and app evaluation services.

The trained ML model is utilized to detect salient UI elements that are to be preserved during display retargeting. During resizing of the UI, with express user permission, content-aware image retargeting techniques are utilized for the preservation of elements identified as important by the UI saliency detection model. Past interactions are utilized, and interpretation or corrective action is performed only upon permission from the user.

## REFERENCES

1. Lu, Huchuan, “Deep learning based salient object detection” accessed July 19, 2018.