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Image Upscaling for High Resolution Screencasting

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ABSTRACT

This disclosure describes techniques for power efficient screencasting of high resolution content. Per techniques of this disclosure, a mobile device is coupled to a high-resolution display to which the mobile device screencasts content. The mobile device performs low resolution rendering of content. The content is upscaled at the mobile device prior to transmission to the high-resolution display or can be upscaled at the high-resolution display. The upscaling can be performed by a machine learning-based image upscaler that is suitable for real-time processing. Operations such as ray tracing and variable rate shading are performed by the mobile device at a lower resolution than that of the high-resolution display, thereby enabling lower power consumption. Further, adaptive hybrid rendering can be utilized whereby ray tracing is performed only for specific surfaces such as shadows, reflective puddles, and metalwork while other geometric surfaces use traditional rasterization techniques. Capabilities of the high-resolution display can be verified as part of an initial capability negotiation at the time of connection setup. The described upscaling techniques can also be used in other use cases such as video recording, video conference, connecting a smartphone to an auxiliary display in a car, etc.

KEYWORDS

- Screencast
- Screen mirroring
- Screen projection
- Super-resolution
- Image upscaling
- Video upsampling
- Video upscaling

BACKGROUND

Users of a smartphone or another mobile device can screencast content from the mobile device to a higher resolution display such as a television or smart display. For example, users can use their mobile phone as a game console and screencast to a large screen television where the game user interface is displayed, providing them a better playing experience. In some scenarios, a user can screencast video or other image content from their mobile device to a larger display to enable other individuals to view the content on the larger display, thereby providing a superior communication and entertainment experience. However, rendering content at high resolutions such as 4K at mobile devices poses a challenge due to the limited processing capabilities and power and thermal constraints of mobile devices. Additionally, operations such as ray tracing at high resolution can be prohibitively expensive to achieve on a mobile device.

DESCRIPTION

This disclosure describes techniques for power efficient screencasting of high resolution content from mobile devices. Per techniques of this disclosure, a low power screencasting platform is utilized that uses low resolution rendering of content combined with a machine learning based image upscaler for real-time processing and screencasting at high resolutions to a display device.

The platform enables the ordering of rays and grouping of coherent rays together for rendering ray tracing for low-resolution content on the mobile device. The ray-traced low-resolution content is then converted to high-resolution content using the image upscaler.

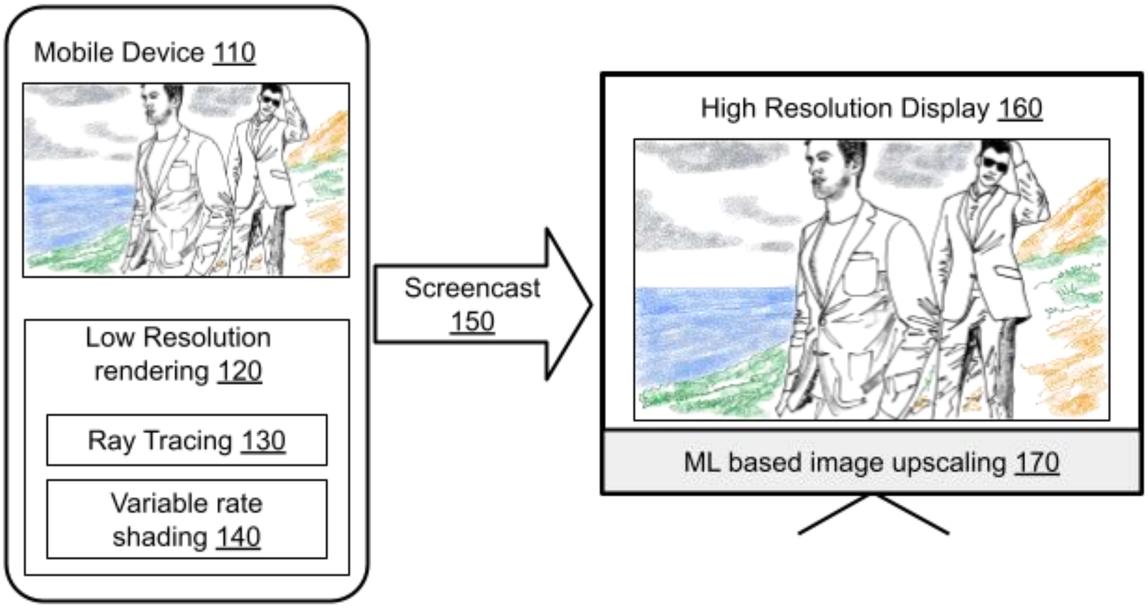

Fig. 1: Low resolution rendering is combined with image upscaling

Fig. 1 depicts an example of low resolution rendering combined with image upscaling, per techniques of this disclosure. In this illustrative example, a mobile device (110) is utilized to screencast (150) content to a high-resolution display (160). As depicted in Fig. 1, the content is rendered at a lower resolution (120). Operations such as ray tracing (130) and variable rate shading (140) are performed at the low resolution, thereby enabling low power consumption at the mobile device. In some implementations, adaptive hybrid rendering can be utilized whereby ray tracing is performed only for specific surfaces such as shadows, reflective puddles, and metalwork while other geometric surfaces use traditional rasterization techniques.

A pre-trained machine learning (ML) model (170) trained to upscale video content is utilized to upscale the low resolution content that has been screencast to the higher resolution of the display, with minimal perceptible image quality loss. Optionally, the ML model can be trained specifically for the type of content that is to be upscaled. The higher resolution content frames generated by the ML model are displayed by the larger display. While Fig. 1 shows ML-based content upscaling being performed at the display, it is also possible to use the trained ML model on the mobile device. Further, the ML model can also be implemented in a manner such that the upscaling can be performed partially at the mobile device (110) and partially at the high-resolution display (160).

When content upscaling is performed at the mobile device, suitable encoding, e.g., a H265 encoder, can be utilized to encode the content stream prior to being cast to the higher resolution display. In some implementations, the ML model for image upscaling can be implemented by utilizing a hardware accelerator that is available on the mobile device.

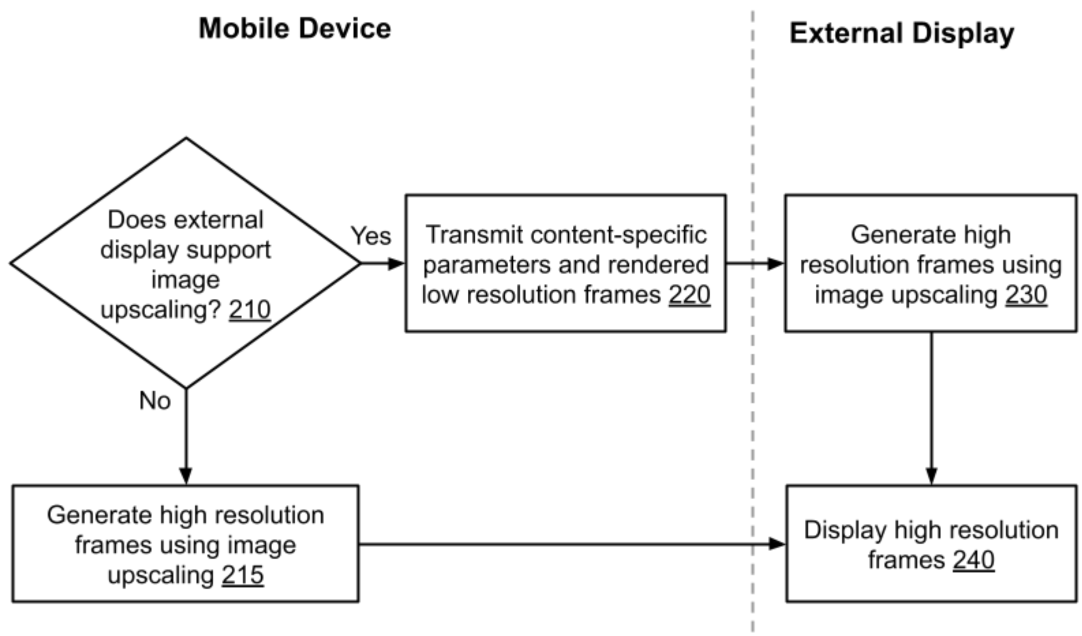

Fig. 2: Method for high resolution screencasting

Fig. 3 depicts an example method for low resolution rendering combined with image upscaling, per techniques of this disclosure. At a time of initiation of a screencast from a mobile device, a capability negotiation is performed to determine whether the external display supports image upscaling (210). If it is determined that the external display can support image upscaling, content-specific parameters for image upscaling and rendered low resolution content are transmitted (220) to the external display. At the external display, image upscaling is performed (230) to generate high resolution frames, which can be displayed (240). If it is determined that the external display does not support image upscaling, image upscaling is performed (215) at the mobile device and high resolution frames are transmitted to the external display.

The described techniques can provide power savings as well as mitigate thermal effects at the mobile device while still enabling visually lossless high resolution screencasting to external display devices. The described upscaling techniques can also be used in other use cases such as video recording, video conference, connecting a smartphone to an auxiliary display in a car, etc. Application programming interfaces (APIs) can be specified to ensure smooth interoperability of mobile devices and display devices when the described upscaling techniques are used when the mobile device is screencasting. The APIs can be transparent to hardware implementation and can support heterogeneous computing on different platforms.

CONCLUSION

This disclosure describes techniques for power efficient screencasting of high resolution content. Per techniques of this disclosure, a mobile device is coupled to a high-resolution display to which the mobile device screencasts content. The mobile device performs low resolution rendering of content. The content is upscaled at the mobile device prior to transmission to the high-resolution display or can be upscaled at the high-resolution display. The upscaling can be performed by a machine learning-based image upscaler that is suitable for real-time processing. Operations such as ray tracing and variable rate shading are performed by the mobile device at a lower resolution than that of the high-resolution display, thereby enabling lower power consumption. Further, adaptive hybrid rendering can be utilized whereby ray tracing is performed only for specific surfaces such as shadows, reflective puddles, and metalwork while other geometric surfaces use traditional rasterization techniques. Capabilities of the high-resolution display can be verified as part of an initial capability negotiation at the time of connection setup. The described upscaling techniques can also be used in other use cases such as video recording, video conference, connecting a smartphone to an auxiliary display in a car, etc.

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