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Automatic Camera Switching For Multi-camera Video Conferencing Setups

ABSTRACT

When a user participates in a video conference while using a multi-monitor setup, the user’s video feed often shows the user looking away from the camera when the user views a monitor that is in a different direction than the camera, even when such a monitor includes another camera. This disclosure utilizes computer vision techniques, such as face detection and head pose estimation, to automatically switch between multiple available cameras based on detecting the one that the user is looking toward. Such automatic switching ensures that the user’s video feed in the video conference shows the user looking towards the camera, thus enabling better eye contact.

KEYWORDS

- Face detection
- Head pose
- Camera switching
- Videoconference
- Video call
- Eye contact

BACKGROUND

When a user participates in a video conference while using a multi-monitor setup, the user’s video feed often shows the user looking away from the camera when the user views a monitor that is in a different direction than the camera, even when such a monitor includes another camera. When the user looks away in this manner, it prevents eye contact in the video conferencing, thereby taking away from the human aspect of the video call.
Fig. 1: User participates in a videoconference with a dual-monitor, single-camera setup

Fig. 1 illustrates an example of a user (108) participating in a video conference multi-monitor computer setup using a single-camera (102). In this setup, a camera (102) is attached to the first computer monitor (104).

Fig.2: User facing the camera directly when viewing Monitor 1, but at an angle when viewing Monitor 2
Fig. 2 illustrates the captured video feed when the user faces the computer monitor with the camera, versus the image captured when the user faces the second computer monitor (106). When the user faces the computer monitor 1, the camera captures the user’s image (202) as looking directly at the camera, while when the user looks at the second computer monitor, the captured image (204) shows the user looking away from the camera. Some video conferencing computer applications support multiple cameras; however, the user needs to manually select the camera that is used during the video conference.

DESCRIPTION

This disclosure addresses the above-described problems of maintaining eye contact throughout a video conference by automatically switching the video feed provided in the video conference to the camera that the user is determined to be looking at. Videoconferencing applications can include an option to automatically select the camera per the described techniques to enable the user to maintain eye contact even as they switch between different monitors.
Fig. 3 illustrates an example of a multi-camera, multi-monitor computer setup. The user participates in a video conference with a dual monitor, dual camera setup. A first camera (302) is in the same direction as a first computer monitor (306), while a second camera (304) is in the same direction as a second computer monitor (308). For example, the cameras may be integrated in the monitors, e.g., all-in-one PCs, laptop or tablet devices, or standalone monitors with integrated cameras, or may both be coupled to the computer that the user utilizes to participate in the video conference. Still further, the user may utilize an auxiliary device, e.g., a smartphone or a wearable device, as a secondary camera while participating in the video conference.

![Captured image when user is facing computer monitor 1](402)

![Captured image when user is facing computer monitor 2](404)

**Fig. 4: Automatically switching the camera based on where the user is looking to provide user video in which the user faces the camera directly**

Per techniques of this disclosure, when automatic camera switching is enabled in the video conferencing application, the video feed from the appropriate camera is selected such that the user is always visible and looking towards the camera. Fig. 4 shows that the captured image has the user looking towards the camera irrespective of the monitor at which the user is looking.

To enable automatic switching, the video feed captured from each of the cameras is analyzed to determine the user’s head pose. Face detection techniques can be utilized to locate
the user’s face within the video feed from each camera, and head pose estimation can be utilized to determine the camera that the user is looking towards. For example, when the user is looking towards a camera, the corresponding head pose is such that most or all of the user’s face is visible in the feed and the neck is straight, whereas when the user is looking away from the camera, only a portion (e.g., one side) of the user’s face may be visible, with the neck turned.

Face detection and head pose estimation is performed locally on the user’s device, for the specific purpose of camera selection, and no user data is stored. The user can choose to enable or disable automatic camera switching, and may select what data can be utilized for head pose estimation. If the user denies permission for use of the video feed, head pose estimation based camera switching is not performed.

Automatic camera switching can be built into any video conferencing application, or can be provided as a system-level feature, with the user’s permission. While the foregoing discussion refers to video conferencing, the described techniques can also be used in other applications such as automatic monitoring, multi-camera video streams, etc.

CONCLUSION

In this disclosure, a multi-camera setup, e.g., a webcam connected to each computer monitor, is used for video conferencing. The techniques of this disclosure consist of applying computer vision principles, such as face detection and head pose estimation, for automatically switching between available webcams based on the one at which the user is looking. The techniques use an ‘auto-cam’ mode to enable smart automatic switching between webcams to have the user always be visible and directly looking at the camera. Thus, the user can achieve better eye contact video conferencing.