Technical Disclosure Commons

Defensive Publications Series

July 2020

LIDAR-ASSISTED AUTO FOCUS TO ENABLE SNAPSHOTS OF CLOSE OBJECTS

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ABSTRACT

Combining light detection and ranging (LIDAR) with the phase detection auto-focus (PDAF) capabilities of a sensor provides a robust emulation of a document camera on a collaboration endpoint device or system. LIDAR and PDAF can reliably indicate that an object is held close to the camera, PDAF can be used to focus and verify focus, and a snapshot image of the current scene can be sent over a presentation channel.

DETAILED DESCRIPTION

Dedicated collaboration endpoint devices that integrate a display, microphone, camera, and motion/distance sensors can enhance the experience of online meetings that include audio, video, and document sharing. However, such collaboration endpoint devices may not have a dedicated document camera. Known systems have auto focus algorithms that work by focusing on a prominent or largest feature in the scene, but attempt to detect when an object is held close to the camera and will then enter a "macro mode" and focus on that object. Entering this mode will typically fail if the object the user is holding up is small, has few edges or visible details, or if the user is unable to keep the object still. Unfortunately, holding an object very close to the camera makes it lose its details simply because it is out of focus, and entering this mode can be cumbersome. Further, it is impractical for a person to display an object while holding it in front of himself/herself for an extended time, and it is also difficult to hold an object in front of the camera while simultaneously pointing and describing.

Auto-focus with PDAF is known, as is auto-focus with LIDAR / RADAR input. However, there do not appear to be any known systems that emulate a document camera in a personal system by presenting a snapshot from the camera system based on LIDAR / PDAF input.

A collaboration endpoint device and a focusing technique are proposed which involve an image sensor supporting Phase Detection Auto Focus (PDAF). With PDAF, it is possible to detect that the image is not in focus, and it is possible to calculate whether focus needs to be moved towards infinity or macro ("near") in order to achieve focus.

The default mode in the auto focus algorithm typically attempts to focus on a distinctive feature in the field of view such as, for example, the face of a person that is most prominent or central. However, if an object with sufficient details is held close to the camera, the algorithm enters "macro mode" and tries to focus on the nearest object instead. A successful result from this mode is seen below:

A difficult problem to solve with only PDAF data is to robustly detect a close object. Due to the depth of focus, when the current focus is set to the distance to the user, an object held close to the camera will be out of focus and all details and contrast are lost. PDAF works very well when the object is close to in-focus, but gives unreliable data when focus is completely off. It is possible to search towards near when there are indications that an object is near the camera, but this yields a very disturbing user experience in situations where this assumption is wrong.

A LIDAR can indicate the distance to the closest object in front of the sensor and gives precise distance estimates for shorter distances. Another advantage is that the LIDAR does not require contrast or edges in order to calculate the distance. The result is that an object can be determined to be close to the camera with a high degree of confidence. Given knowledge that an object is close to the sensor, it is possible to move the focus towards near. As the object gets closer to focus it will, in most situations, be possible to use PDAF to lock focus. If the objects lacks the necessary contrast and details for a PDAF search it is also possible to use the LIDAR input as the only parameter for setting the focus position.

When the object is in focus (verified by the PDAF and/or LIDAR data), the system can automatically grab a snapshot of the current camera image. In order to assist the user in this process, selfview should be turned on automatically such that the object can be positioned correctly. This distance measure from the LIDAR can also be used to determine when the user is holding the object still to minimize the possibility for motion artifacts. To further improve the image quality of the snapshot, it is possible to use the display itself as flash before the snapshot is taken, just like on modern, front-facing mobile cameras.

After the snapshot is taken, it is possible to perform various image enhancement algorithms in order to make the object more legible. Based on the PDAF data, it is also possible to crop out the area that is in focus, e.g., keep only the desired part of the image above. This snapshot can then be offered to the user as a presentation source and, if accepted, sent over the presentation channel and shared to the relevant audience, such as meeting attendees. A flowchart summarizing the LIDAR-assisted auto-focus technique is shown below.