May 2023

Revisiting Localized 3D Photographs Using Augmented Reality

Kathleen Alexandra Bryan

Shiblee Hasan

Revisiting Localized 3D Photographs Using Augmented Reality

ABSTRACT

This disclosure describes techniques that couple panoptic reconstruction with image localization and tracking to enable users to revisit their photographs in three-dimensional augmented reality at any time after the photo is taken. A user that takes a two-dimensional photo of some scenery, e.g., a city skyline, and then, years later, revisits the spot where the photo was taken is offered a user interface, e.g., a virtual slider in the field-of-view to see a before and after comparison of how the scenery has changed since the user's last visit. Based on location similarity, the current view is matched, and the user is provided guidance to adjust their position to obtain a close match between the photograph and their current view.

KEYWORDS

- Augmented reality (AR)
- Localized AR
- Sparse map
- LiDAR
- Panoptic reconstruction
- Reminiscing
- Revisiting memories
- Image registration
- Machine learning

BACKGROUND

Currently, photography is generally two-dimensional, although machine learning techniques (panoptic reconstruction) exist that can reconstruct a three-dimensional model from a two-dimensional photograph.

DESCRIPTION

This disclosure describes techniques that couple panoptic reconstruction with image localization and tracking to enable users to revisit their photographs in three-dimensional augmented reality at any time after the photo is taken. Consider a user that takes a two-dimensional photo of some scenery, e.g., a city skyline, and then, years later, revisits the spot where the photo was taken. Wearing augmented reality glasses, the user can move a virtual slider in the field-of-view to see a before and after comparison of how the scenery has changed since the user's last visit.

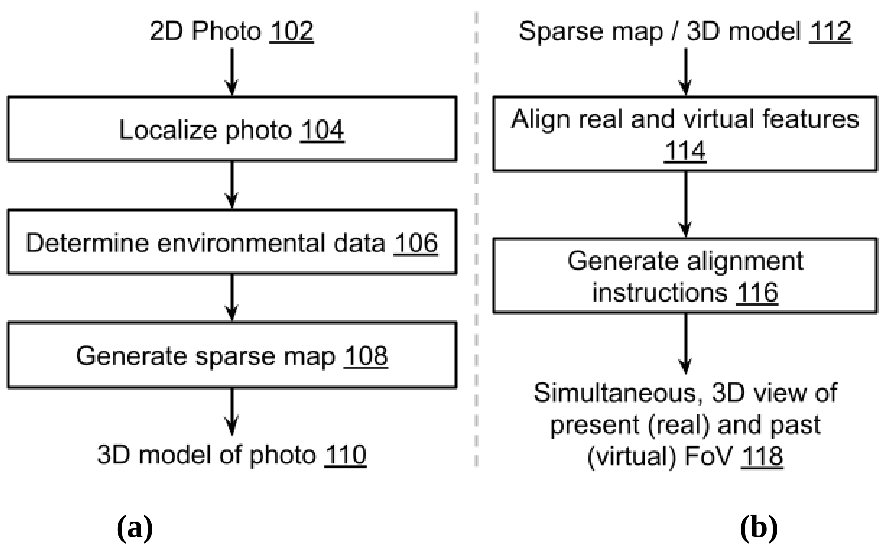

Fig. 1: Localized 3D photographs that can be revisited using augmented reality: (a) During the capture of the original photo; (b) Re-visiting the location of the photo capture

Fig. 1 illustrates localized 3D photographs that can be revisited using augmented reality. As illustrated in Fig. 1(a), the user takes a photo (102), e.g., of people, scenery, etc., using a camera, e.g., from their mobile device or wearable AR device. With user permission, the photo is localized (104), e.g., latitude, longitude, altitude, camera orientation, etc. at the time of photo capture are obtained using suitable sensors such as global/local positioning systems (GPS), inertial measurement units (IMUs) of the device, etc.

Further, environmental data such as the distance of the user from various landmarks in the field-of-view is determined (106) using e.g., LiDAR (light detection and ranging), parallax-based techniques, etc. A sparse map that includes key visual features, pose graphs, distances to landmarks, etc., is generated (108). A three-dimensional model of the photo is obtained (110) using the sparse map and panoptic reconstruction. The 3D model is aligned with the sparse map.

As illustrated in Fig. 1(b), at a later time (e.g., a few moments or a few years later), when the user revisits the location where the photo was taken, the sparse map or 3D model can be used (112) to align features from the present (real) and past (virtual) fields-of-view (FoV) (114). With user permission, the current latitude, longitude, altitude, AR device orientation, distances to landmarks, etc. are compared to those stored as metadata in the original 2D photo to generate alignment instructions (116). The instructions enable the user to align their current (real) FoV with the sparse map or three-dimensional model created from the originally captured two-dimensional photo.

Upon alignment, the user can view a simultaneous 3D view of the present (real) and past (virtual) FoVs (118), thereby revisiting in augmented three-dimensional reality the scenery at the time and location that the original 2D photo was taken. For example, the user can overlay a past (virtual) three-dimensional view with the present (real) one or can operate a virtual slider to compare the past (virtual) three-dimensional view with the present (real) one. The user can thus revisit their memories when physically at a place the user had visited in the past.

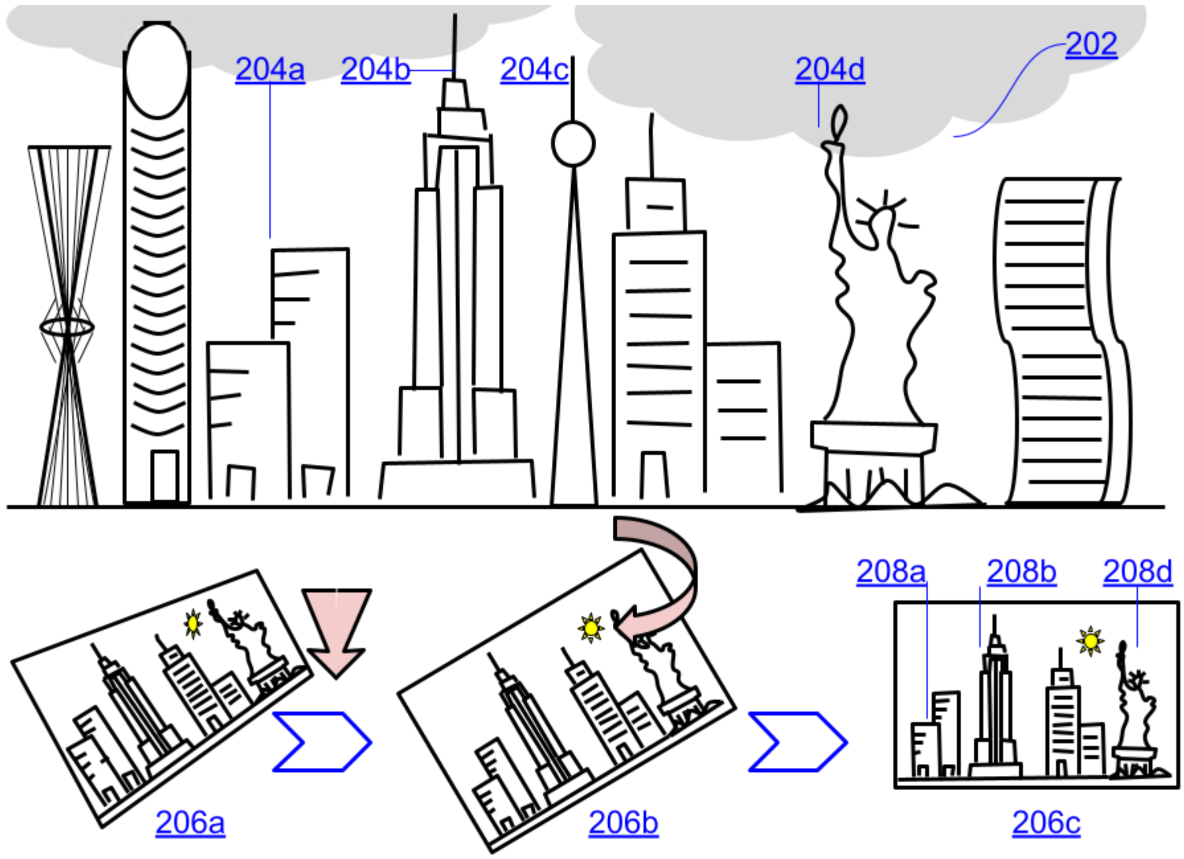

Fig. 2: Revisiting memories using augmented reality

Fig. 2 illustrates an example of revisiting a user's memories. A user took a 2D photograph of a city's skyline many years ago. The user is presently at or near the location where the original photograph was taken, and her present (real) view of the skyline (202) includes several landmarks (204a-d).

With user permission to access their location and to access photographs taken earlier (e.g., available in the user's photo library), the user's old photograph of the skyline is obtained (206a) and compared (206b) with the present skyline. Based on the comparison, instructions are generated and provided to the user to move or change her visual orientation with the goal of matching landmarks (208a-d) in the old photograph with those visible in the present skyline.

As the user moves and changes her visual orientation, the relative orientation of the old photograph and its overlap with the present view changes (206a-c) until landmarks in the old photograph (208a-d) match with the landmarks (204a-d) of the present (real) view. Not all landmarks are required to match to determine an overall match between the present view and the past photograph; for example, landmark 204c appears in the present skyline but is absent in the old photograph.

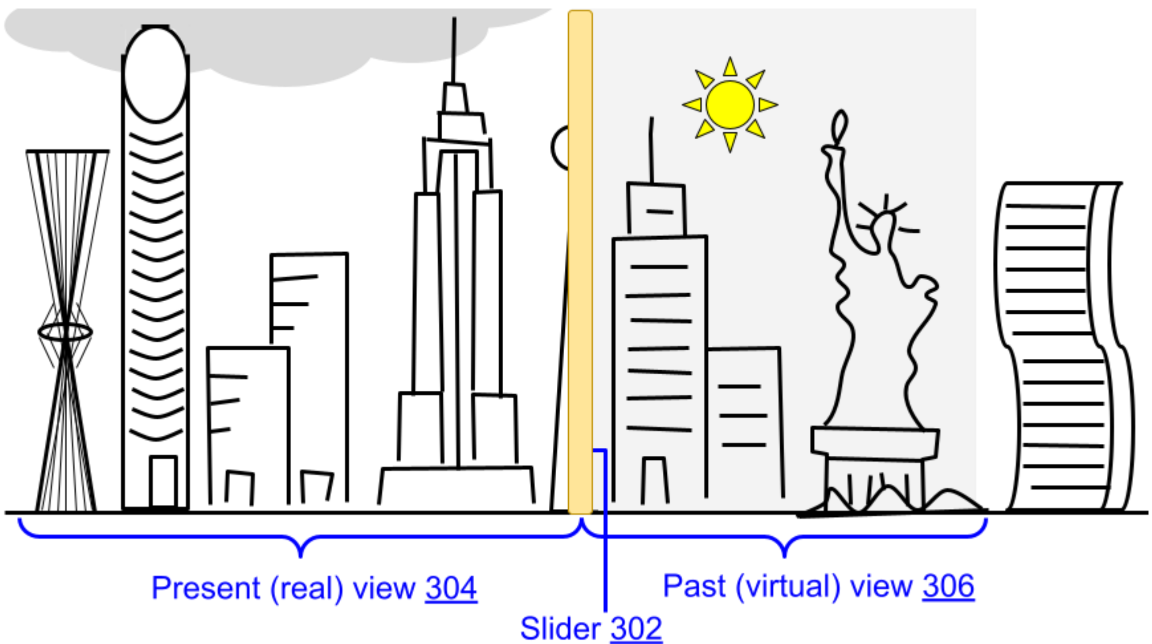

Fig. 3: Augmented reality view comparing past photograph with present world

When a match is determined, the present view and the past photograph can be superimposed upon or compared with each other in three dimensions in the user's augmented reality view. For example, as illustrated in Fig. 3, the user can move a virtual slider (302) in their AR view to compare their present (real) three-dimensional view (304) with the past (virtual) three-dimensional view (306) obtained from the photograph.

The described techniques can be made available by a smartphone, augmented reality device (e.g., AR glasses), etc. Location determination, view comparison, and generating instructions for the user are performed locally on the user device. If the user permits, a portion of the computation may be performed on a server.

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 photographs, 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. 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 techniques that couple panoptic reconstruction with image localization and tracking to enable users to revisit their photographs in three-dimensional augmented reality at any time after the photo is taken. A user that takes a two-dimensional photo of some scenery, e.g., a city skyline, and then, years later, revisits the spot where the photo was taken is offered a user interface, e.g., a virtual slider in the field-of-view to see a before and after comparison of how the scenery has changed since the user's last visit. Based on location similarity, the current view is matched, and the user is provided guidance to adjust their position to obtain a close match between the photograph and their current view.

REFERENCES

[1] Sukan, Mengu. "Augmented reality interfaces for enabling fast and accurate task localization" available online at https://academiccommons.columbia.edu/doi/10.7916/D8FJ2V2K accessed Apr. 8, 2023.

[2] Dahnert, Manuel, Ji Hou, Matthias Niessner, and Angela Dai. "Panoptic 3D scene reconstruction from a single RGB image" available online at https://arxiv.org/abs/2111.02444# accessed Apr. 8, 2023.