6-DOF TRACKING USING VISUAL CUES

TECHNICAL FIELD

This disclosure relates to 6-DoF (Degrees of Freedom) tracking technology.

BACKGROUND

Augmented reality devices are configured to display one or more images and/or objects over a physical space to provide an augmented view of the physical space to a user. The objects in the augmented view may be tracked by tracking systems that detect and measure coordinate changes for the moving objects. Tracking moving objects in augmented reality may be difficult if a background associated with the moving object includes sparsely populated content or content that is difficult to differentiate from the object. For example, when a tracking system is directed to track a moving object and any related content in front of a featureless wall, motion may not be properly tracked and, in turn, may not be properly displayed to the user according to actual captured motion. Thus, improved systems and methods may be desired for tracking objects and content in a featureless environment surrounding particular objects.

SUMMARY

A system of one or more computers can be configured to perform particular operations or actions by virtue of having software, firmware, hardware, or a combination of them installed on the system that in operation causes or cause the system to perform the actions. One or more computer programs can be configured to perform particular operations or actions by virtue of including instructions that, when executed by data processing apparatus, cause the apparatus to perform the actions. In one general aspect, a computer-implemented method includes at least one processing device and memory storing instructions that when executed cause the processing device to perform operations including obtaining, from a first tracking system, an initial three-dimensional (3D) position of an electronic device in relation to image features captured by a camera of the electronic device, and obtaining, from a second tracking system, an orientation associated with the electronic device. Responsive to detecting a movement of the electronic device, obtaining, from the second tracking system, an updated orientation associated with the detected movement of the electronic device, generating and providing a query to the first tracking system. The query may correspond to at least a portion of the image features and including the updated orientation and the initial 3D position of the electronic device.

The method may also include, responsive to detecting the movement, receiving, responsive to the query, a plurality of position changes for the portion of the image features in relation to the initial 3D position of the electronic device, generating, for a sampled number of the plurality of position changes, an updated 3D position for the electronic device, generating a 6-DoF pose using the updated 3D positions and the updated orientation for the electronic device, and providing, for display on the electronic device, a camera feed depicting movement of the image features based on the movement of the electronic device, according to the generated 6-Dof pose. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

Implementations may include one or more of the following features. The method where the updated 3D positions are generated using a periodic sampling of three dimensions of data for a plurality of image frames representing the position of the portion of the image features relative to the position of the electronic device. The method where the periodic sampling is performed using a threshold frame rate configured to reduce jitter in the movement of the portion of the image features depicted in the camera feed provided based on the generated 6-DoF pose. The method where providing the camera feed depicting movement of the image features based on the movement of the electronic device according to the 6-DoF pose includes providing placement of virtual objects associated with the user in the camera feed according to the 6-DoF pose each time the electronic device is moved. The method where the image features include: portions of a face of a user being captured by the camera of the electronic device, the camera being a front facing camera and in which augmented reality content associated with the user is captured by the front facing camera. The method where the first tracking system executes a facial feature tracking algorithm configured to determine 3D location changes for the image features associated with at least one selected facial feature and the second tracking system is an inertial measurement unit (IMU) installed on the electronic device. The method where combining output from the first tracking system and output from the second tracking system enables tracking and placement of augmented reality content based on the generated 6-DoF pose, and responsive to the detected movement of the electronic device.

The method may also include obtaining the updated orientation associated with the detected movement of the electronic device from the second tracking system being performed in response to determining that the first tracking system is unable to provide both the position and orientation with 6-DoF. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

In another general aspect, an electronic device is described. The electronic device may include a first tracking system configured to generate a 6-DoF pose for the electronic device corresponding to image features depicted in a camera feed displayed by the electronic device. The 6-DoF pose may be generated from a determined orientation for the electronic device, and a determined position for the electronic device. The determined position may be calculated using a facial feature tracking algorithm configured to detect three-dimensional location changes for at least one selected facial feature in the image features in the camera feed displayed by the electronic device. The second tracking system may include at least one inertial measurement unit (IMU) for determining an orientation of the electronic device in three-dimensional space The electronic device may include at least one processor coupled to memory and configured to trigger the first tracking system to generate the 6-DoF pose for the electronic device if the first tracking system operates within a predefined confidence threshold, trigger the second tracking system to generate an alternate 6-DoF pose if the first tracking system failed to operate within the predefined confidence threshold. The alternate 6-DoF pose may be generated by combining the determined position from the first tracking system and the orientation of the second tracking system. The processor may further trigger, for display on the electronic device, an updated