DYNAMIC ADJUSTMENT OF THE HOLOGRAMS BASED ON SLAM METHODS IN AUGMENTED REALITY GLASSES*

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Abstract
Augmented Reality (AR) systems rely on accurately tracking and registering the user’s head and virtual objects to create a realistic AR experience. However, tracking the user’s head in dynamic environments presents challenges due to rapid head movements, which can cause previously tracked features to be out of the system’s range of view. To address this challenge, a technique based on simultaneous localization and mapping (SLAM) is proposed in this paper for tracking head movement using Microsoft HoloLens 2. The SLAM-based approach combines data from an RGB camera, depth sensors, and an inertial measurement unit (IMU), including an accelerometer, gyroscope, and magnetometer, to track the position and orientation of the device.

The accuracy and reliability of the proposed system were evaluated through an experiment conducted in unity 3D and Microsoft HoloLens 2, using the Microsoft Mixed Reality Toolkit (MRTK) to simulate the agile movement scenarios. The results demonstrate the effectiveness of the SLAM-based approach in accurately tracking head movements, even in a dynamic environment.

The proposed technique based on SLAM for dynamic adjustment of holograms in AR systems can enhance the user experience, improve the accuracy and reliability of tracking, and make it suitable for various applications such as remote assistance, training, and gaming.

The implementation
There is a rise in interest in augmented reality and creating an immersive experience because of its many applications. Augmented reality has revolutionized how we interact with the world around us. It merges the physical world with a virtual object to create a hybrid environment that may be utilised for various things, including robotics, gaming, marketing, education, and medical treatment[1]. One of the hardest parts of making an AR experience work well is ensuring that the digital content matches the real world. This is where the dynamic adjustment of holograms based on the SLAM (simultaneous localization and Mapping) method comes into play. SLAM is a technology that enables mapping an unknown environment while detecting the user’s location[2]. Using sensors like cameras and accelerometers, inertial measurement unit (IMU) SLAM techniques map the area and follow the user's motions.

Implementing dynamic adjustment of holograms based on SLAM methods in augmented reality involves a combination of sensor data collection, map building, hologram placement, and continuous dynamic adjustment to ensure that the holographic content is appropriately aligned with the real-world environment. The SLAM system continually updates the map and the user's position on it as the user moves around [3]. The holographic content’s position and orientation are then adjusted by the AR glasses device using the SLAM algorithms to make it remain in line with the user’s perspective. A seamless and immersive AR experience depends on this dynamic adjustment. It enables holographic content to blend seamlessly into the environment rather than being superimposed on top of it. Computer vision algorithms can produce high spatial precision in addition to the device's (Position) sensor technologies (magnetometers, gyroscopes, accelerometers).

Fang et al.[4] introduced a hybrid tracking and registration technique that uses a gyroscope and natural features to estimate the operator's posture in real-time and smoothly merge virtual aid information with the outside world. AR glasses can be used to provide real-time directions and guidance to users[5]. For example, holographic arrows or signs could be overlaid onto the real world, with the hologram being dynamically adjusted as the user moves.

AR glasses can provide interactive and hands-on training experiences for learners in education and training[6]. For example, a trainee could use AR glasses to overlay instructions and guidance onto a real-world task, with the holograms being dynamically adjusted based on the learner's movements. In medical and healthcare, AR glasses can provide doctors and healthcare professionals with real-time information during surgeries and other procedures[7]. For instance, a holographic overlay of a patient's vital signs could be dynamically adjusted based on the doctors' movement and perspective, providing them with important information hand-free.

The effectiveness of tracking and registration affects how the augmentations are aligned. Due to head-tracking lag, occlusion, and drift, the user may feel startling or disturbing effects. The quality of the AR experience may be impacted by these challenges, which must be overcome to offer a fully immersive AR experience. Over a lengthy period, many different AR SLAM-based algorithms for simultaneous localization and mapping have been developed, with contemporary approaches showing outstanding accuracy [8], [9]. However, inaccuracies in pose estimates commonly happen due to difficult visual conditions or device movement.

In this paper, we introduce a technique based on the SLAM algorithm using augmented reality glasses (Microsoft HoloLens 2) to track the user's head and adjust the holograms based on the user's perspective. We employ SLAM techniques on Microsoft HoloLens and Unity 3D application to show the capability of our technology to learn pose estimation and update the hologram in line with the user's view.

Accurate and responsive head tracking is critical for creating a convincing and comfortable AR experience, as any lag or inaccuracies in the tracking can break the illusion of the virtual contentment being part of the real world, leading to discomfort or distortion of the user. AR glasses' dynamic hologram adjustment based on SLAM techniques has much potential for uses like entertainment and remote support. However, because this technology is still in its early stages, more research is needed to improve its precision and dependability.

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