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SOFTWARE SYSTEM WITH SUPPORT FOR AUGMENTED REALITY

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Abstract: The essential components of AR include combining of real and virtual objects, registration in 3D and real-time interaction . In the past years, various algorithms and systems have been developed to address tracking and registration issues in AR. Based on these algorithms, several well-known AR software platforms have been developed to facilitate the development of various specific AR applications.

Keywords: Augmented reality, virtual reality, markers, softwar system, AR applications

Tracking and registration is the basic enabling technology of AR. Without accurate tracking and registration, the virtual and real objects cannot be merged seamlessly. Various sensors have been used to track the head of the users so as to calculate their viewpoints, which is crucial to support static and dynamic registration. In this section, CV-based tracking and registration will be focused on as these tracking methods analyse the images captured by a video camera to estimate the camera pose. The existing tracking and registration algorithms in AR systems can be roughly classified into marker-based tracking, natural feature-based tracking and model-based tracking.

Fiducial markers have been widely used in AR applications. These markers have geometric features or unique patterns which make them easy to be detected and identified in a video stream. Marker-based tracking provides a robust and stable solution for the prepared environment. Based on feature detection and pattern matching, different markers can be recognized and camera pose can be estimated. ARToolKit is the most well-known tracking library in this field. In this platform, square markers with asymmetric patterns are designed and detected to augment virtual objects seamlessly. It is an open-source and free platform and numerous ARToolKit-based applications have been developed, such as the assembly, design, robot programming, CNC machining, education, etc. Integrating ARToolKit library with the powerful OpenSceneGraph advanced graphics libraries, osgART has been developed to support marker tracking and AR rendering. In addition, various libraries based on ARToolKit have been developed considering various programming platforms. FLARToolKit has been designed to develop web-based AR applications. FLARManager has been developed to support the building of AR application for Flash. SLARToolKit is a library to support the development of AR applications with Silverlight.

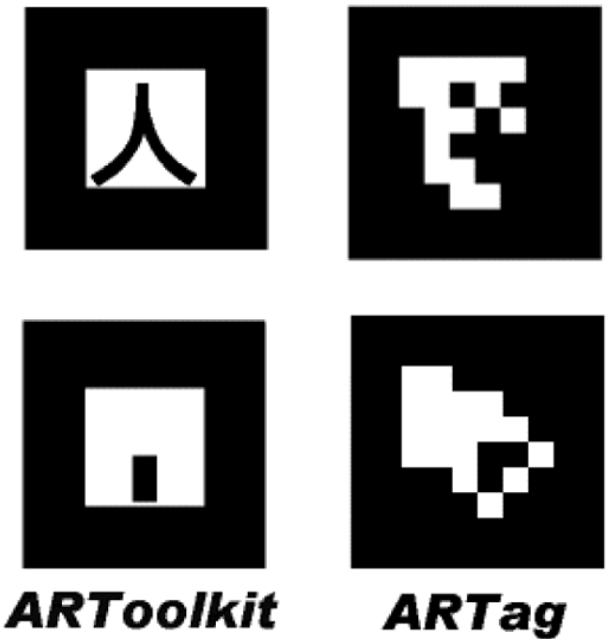

Fig.1. Markers for ARToolkit and ARTag platform library

ARTag is an open source platform developed several years after ARToolKit. ARTag uses more complex image processing and digital symbol processing methods. ARTag outperforms ARToolKit in stability and resistance to illumination changes. In ARTag, 2D barcode markers are implemented, such that there is no need to train any markers or load any pattern files.

Natural feature tracking can enhance the tracking stability and extend the tracking range. With natural feature tracking, AR applications can be developed for the unprepared environment. Most current natural feature tracking methods are based on the robust point matching approach. Various feature descriptors, such as Binary Robust Independent Elementary Features (BRIEF), ferns features, Scale Invariant Feature Transform (SIFT) features, Speeded Up Robust Features (SURF), etc., have been explored to facilitate feature detecting and matching.

Parallel Tracking and Mapping (PTAM) is a notable platform for estimating camera pose in an unknown scene. Through the methods of processing the two tasks, namely, tracking and mapping, in parallel threads and keyframe-based mapping, detailed maps of the unknown environment can be reconstructed with many landmarks. With the detailed maps, virtual objects can be registered onto the real world. This platform only supports the tracking of static and limited environments. Parallel Tracking and Multiple Mapping (PTAMM) was developed as an extension of PTAM. PTAMM is able to use multiple independent cameras and create multiple maps in which different applications can be created in individual maps. In this platform, the cameras can switch automatically between maps by comparing the descriptors between the keyframes and the camera image. With this scheme, PTAMM supports the exploring of large environment with multiple mapped workspaces.

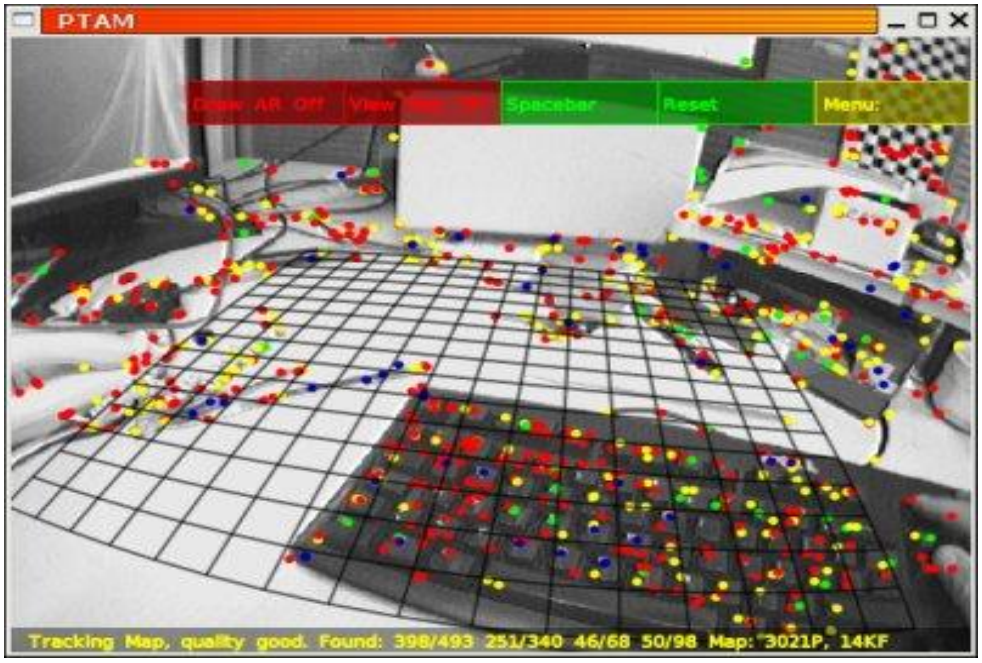

Fig. 2. Visualisation Parallel Tracking and Mapping

ARToolKitNFT is another C/C++ software library that supports natural feature tracking with which virtual objects can be augmented onto textured surfaces. It is compatible with the ARToolKit library. BazAR is a library that supports feature points detection and matching based on computer vision. In this library, a keypoint-based approach has been developed. The authors for- mulated the wide-baseline matching of keypoints between the camera images and those in the model images as a classification problem to shorten the on-line computing time significantly. In this approach, issues such as large perspective and scale variations have also been addressed with a simple and fast keypoint detector.

Instead of using fiducial markers, model-based tracking matches the detected features with the natural features available from pre-created models, such as appearance, texture, motion, etc. Open Tracking Library (OpenTL) is a model-based tracking library that provides user-friendly APIs and handles multiple objects tracking. This library uses the multi-threading method and GPU-based computing to achieve real-time performance. It is not specifically developed for AR applications, but for general purpose model-based object tracking.

With powerful computing capability and ubiquitous properties, AR applications based on handheld devices have attracted increasing attention in recent years. NyARToolkit is an optimized version of ARToolKit library that supports multiple programming languages and operating platforms. It can also be used to develop AR applications on Android handheld devices. Android ARToolkit (AndAR) is a Java-based software library and supports the development of AR applications on the Android platform. There is also a version of ARToolkit for iOS for supporting the development of AR applications on Apple’s iOS platform. Layar is a mobile platform to display digital information of the environment in the vicinity of the user. Different versions of Layar are provided for Android, Symbian and iOS platforms. Qualcomm Augmented Reality (QCAR) SDK supports the development of AR

applications on Android 2.1, 2.2 and 2.3 devices. Three kinds of objects can be tracked in this library, namely, image targets, multi targets and frame markers. Image targets are texture images with good contrast. Up to five image targets can be tracked simultaneously. Multi targets refer to objects with multiple image targets and targets have fixed spatial relationship. Other image targets can be detected based on the relationship if one of the targets is detected. A frame marker is a special fiducial marker with a unique ID encoded into a binary pattern along the border of the marker image. Any image can be placed in the center area of marker. With this design, the markers look more natural.

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