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INTERNET OF THINGS (IOT) FOR CONTINUOUS VIRTUAL REALITY SPACE: CHALLENGES & VIEW POINT

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Abstract: **This paper addresses a novel virtual reality (VR) system that is based on the real world in which we live. In this paper, we propose an end-to-end system architecture and its element technologies for providing a 6-DOF VR space that is based on the real world. The propose system is realizable with the help of IoT infrastructure. We posit that the IoT environment is the main factor in overcoming the huddle of 6-DOF VR space. The proposed architecture especially considers commercialized smart--phone cameras and video-sharing websites and social network services (SNSs). In contrast to previous work on VR space service that is based on the real world, we design a fully distributed architecture. The proposed system can provide VR space with the movement of the watching user, in other words, 6 DOFs. This paper also includes a detailed survey of both conventional and emerging studies by other researchers.**

Keywords: Internet of Things, Virtual Reality, Virtual Space, Free-viewpoint Video, 360° Video.

I INTRODUCTION

This assumption is realistic because many researchers expect that in the near future, IoT technology will lead to a world that connects not only people to people but also things to things. In this paper we propose an end-to-end system architecture and its element technologies for providing a 6-DOF VR space that is based on the real world. The proposed system is realizable with the help of IoT infrastructure. We posit that the IoT environment is the main factor in overcoming the huddle of 6-DOF VR space. The proposed architecture especially considers commercialized smartphone cameras and video-sharing websites and social network services (SNSs) such as Youtube and Facebook for acquiring and storing the captured real-world images/videos.

II LITERATURE SURVEY

With the rapid development of computer 3D processing capacity and the emergence of low-cost sensors, the technology of augmented reality (AR) and virtual reality (VR) has advanced quickly in recent years, especially in combination with real-world technologies. Firstly, the concepts are summarized, and the difference and connection are analyzed between AR and VR. Then, a typical AR system with software and hardware architecture was presented based on the current research achievements. Three key techniques and related research are introduced in detail. Finally, application of AR in various areas is introduced, especially in the field of military system, equipment support and training simulation.[1]

This paper addresses a novel virtual reality (VR) system that is based on the real world in which we live. The ultimate goal is to implement it as though a VR user freely exists in a place. To this end, it is most important to reconstruct a VR space that provides six degree-of-freedom (DOF), namely, yaw, pitch, roll, surge, sway, and heave. However, most currently released VR services that are based on the real world limit users' movements to three DOF. Even if the services support six DOF, most are highly complex and based on computer graphics. To overcome this problem, we first assume that there is a full Internet of things (IoT) infrastructure for collecting important data for VR space reconstruction. This assumption is realistic because many researchers expect that in the near future, IoT technology will lead to a world that connects not only people to people but also things to things. In this paper, we propose an end-to-end system architecture for the VR space that is based on the real world along with the element technologies that constitute the proposed system. This paper also includes a detailed survey of both conventional and emerging studies by other researchers.[2]

We present a system for interactively browsing and exploring large unstructured collections of photographs of a scene using a novel 3D interface. Our system consists of an image-based modeling front end that automatically computes the viewpoint of each photograph as well as a sparse 3D model of the scene and image to model correspondences. Our photo explorer uses image-based rendering techniques to smoothly transition between photographs, while also enabling full 3D navigation and exploration of the set of images and world geometry, along with auxiliary information such as overhead maps. Our system also makes it easy to construct photo tours of scenic or historic locations, and to annotate image details, which are automatically transferred to other relevant images. We demonstrate our system on several large personal photo collections as well as images gathered from Internet photo sharing sites.[3]

This paper proposes a quasi-dense reconstruction from uncalibrated sequence. The main innovation is that all geometry is computed based on re-sampled quasi-dense correspondences rather than the standard sparse points of interest. It not only produces more accurate and robust reconstruction due to highly redundant and well spread input data, but also fills the gap of insufficiency of sparse reconstruction for visualization application. The computational engine is the quasi-dense 2-view and the quasi-dense 3-view algorithms developed in this paper. Experiments on real sequences demonstrate the superior performance of quasi-dense w.r.t. sparse reconstruction both in accuracy and robustness.[4]

We propose a learning-based image feature points detector. Instead of giving an explicit definition for feature point we apply the methods of machine learning to infer it inductively using a representative training set. This allows for a flexible tuning of the proposed detector to a specific problem that is described by a training set of desired responses. To increase feature points' repeatability and robustness to various image transformations the feature space of the learning algorithm includes raw image moments and image moment invariants. Experiments demonstrate high flexibility in tuning the detector to a specific task, acceptable repeatability of the feature points and robustness to various image transformations.[5]

Trajectory data generated by outdoor activities have great potential for location based services. However, depending on the localization technique used, certain trajectory data could have large errors. For example, the error of the trajectory generated by cellular-based localization techniques is around 100m which is ten times larger than that of GPS-based trajectories. Hence, how to enhance the utility of those large-error trajectories becomes a challenge. We dedicate this paper on improving the quality of trajectory data with large scale of errors. Some existing works reduce the error through hardware aspect which requires information such as the time of arrival (TOA), received signal strength indication (RSSI), the position of cell towers, etc. Moreover, different positioning techniques will result in different hardware-based solutions and different data formats, which violates the generality. Other works study a related but different problem, i.e., map matching, with the aid of road network information, to reduce the uncertainty and the noise of trajectory data. However, most of these approaches are designed for the GPS-sampled data, and hence they might not be able to achieve a similar performance when applied directly to trajectories with large scale of errors. Motivated by this, we propose a general error reduction system namely CLSTERS for trajectories with large scale of errors. Our system solves the problem in a hardware-irrelevant-aspect and only requires the coordinates and the time stamp of each sample point which makes it general and ubiquitous. We conduct the comprehensive experiments using three real-world datasets in three different cities generated by two different localization techniques and the results justify the superiority and the generality of our approach.[6]

III RELATED WORK KEY TECHNIQUES OF AUGMENTED REALITY SYSTEM

As an emerging multidisciplinary research object, AR and its involved techniques are reviewed in detail by Azuma, an authoritative scholar in this field. He concluded that there are three remarkable features[6]: (1) information fusion of realworld and virtual world (virtual reality fusion); (2) real-time exchange; (3) virtual objects added in three-dimensional positioning (3D tracking registration).

A. *Three-dimensional Tracking Registration*

Since the goal of augmented reality is to enhance the perception of the real world by adding virtual objects to the real scene, how to determine the spatial pose information of the virtual object and place it precisely in the real scene, Tracking the registration technology, has become one of the key technologies of the AR system, which is called the three dimensional tracking registration, as the foundation and premise of all the following work.

B. *Real-time Human-computer interaction*

Human-computer interaction is a multidisciplinary technology, including computer vision, psychology, and artificial intelligence, but over the years it has taken a devicecentred mode that needs users to adapt to the machine. This approach is easy to implement technology, but not easy to be used. With the development of sensor, force feedback and other hardware equipment, research on individual differences and perception, and cognitive science development, it has become a key technology in the world's information industry and gradually changes to the user-centred mode.

C. *Virtual Reality Fusion*

(1) Simulation of Depth of Field of Virtual Scene The existing AR systems have almost ignored the depth of field (DOF) effect of virtual scene, making fusion scene not natural and real, lack of immersion, and easy to cause eye discomfort and fatigue. DOF effect can improve the realism and immersion, to provide users with some depth information and truly realize the virtual reality fusion. A number of algorithms about depth rendering have been proposed in the field of computer graphics. The mature depth simulation algorithm first considers the impact of brightness on the DOF, to make up for the existing algorithm and to further improve the immersion of AR system. processing of lighting information; 2) implementing lighting model; 3) light intensity correspondence between real scene and virtual scene.

IV PROPOSED SYSTEM

The proposed end-to-end architecture can be divided into five parts: acquisition, classification, virtual image/video reconstruction, transmission and consumer processing. These are described in the following subsections. Furthermore, to incorporate convincing sound, signal processing methods for VR audio are described in the audio subsection. in which free viewpoint 360° virtual views are provided for users, who can move all directions (i.e., 6-DOFs). To achieve this objective, novel 360° VR view synthesis methods are required. We discuss such methods in the following subsections. This is different from virtual 3D modeling for games that are based on CG and requires a very large number of images or videos. We assume that a variety of images and videos, which are taken by anonymous users, are stored in image/video servers. In the reconstruction of the VR world, efficient classification is necessary. Therefore, metadata such as location, direction, time and weather are also necessary for efficient classification. We assume that the IoT infrastructure is already in place, and it is used to collect important data for seamless VR space reconstruction. Furthermore, we present the directions of future research that are related each stage. Among these, two proposed methods are evaluated to determine their feasibilities.

VI MODULES

Module 1: In contrast to previous work on VR space service that is based on the real world, we design a fully distributed architecture for acquisition, classification, virtual image/video reconstruction, transmission, and consumer processing.

Module 2: Movement: The proposed system can provide VR space with the movement of the watching user, in other words, 6 DOFs.

Module 3: Reasonableness: The proposed VR space service can be realized with commercialized equipments and networks such as smart phone, 360° camera, wired/wireless HMD and SNS, and advanced equipment such as multiple arrayed or light-field cameras.

VII CONCLUSION AND FUTURE WORK

In this paper IoT networks is proposed for the reconstruction of seamless VR space and the proposed architecture is divided into five stages: acquisition, classification, virtual image/video reconstruction, transmission, and consumer processing. In each stage, conventional and novel element technologies are discussed and proposed, respectively, that constitute the proposed system architecture. We assume that the IoT infrastructure is already in place, and it is used to collect important data for seamless VR space reconstruction

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