SWPC 2017 Submission

Title	Demonstration of Large Scale 3D Reconstruction and Its Application using Obstacle Avoidance Use Case
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Summary

3D reconstruction, needed for Virtual Reality (VR) / Mixed Reality (MR), captures shape and appearance of real objects. Reconstruction activity includes tracking a user in a scene so that part of scene visible to the user in real world can be reconstructed and rendered in virtual world, giving user enriching VR/MR experience. Currently, most of the reconstruction techniques fail to do room scale 3D reconstruction, due to storage and memory requirements. This demo shows, by using InfiniTAM IP developed at Oxford university, we can do room scale reconstruction. This reconstructed model when superimposed on VR content, enables obstacle avoidance during game.

Opportunity/Problem

3D reconstruction is a process of capturing shape and appearance of real objects. In recent times, there is a demand for 3D content for Virtual Reality / Mixed Reality (VR/MR) mainstream needs like gaming, education. Supporting 3D reconstruction on Intel client platforms will help in enabling intriguing VR/MR experiences for the end users. This will be an important value add to Intel platforms.

Efficient localization as well as mapping is required for solving 3D reconstruction problem. Localization is a process of finding the position/orientation of camera with respect to its surroundings. Mapping is a process of estimating the scene. Based on location of user, view of reconstructed world that should be visible to user with naked eye, will be rendered. If location changes, surface visible to user also changes. Most of the modern day 3D reconstruction algorithms perform at 'small' scale. Additionally, the frame rate of reconstruction is not high enough to consider them for real time operations. Storing and processing information of large volume of space, needs high storage and compute capabilities. Thus, performing 3D reconstruction at room-scale in real time becomes a challenge. The base data required for 3D reconstruction is the object's distance from sensor. Various methods have been evolved based on the method of obtaining depth information. Among them, camera based depth sensors are affordable. Using these depth sensors, one can develop a 3D reconstruction framework to scan the geometry of the environment. InfiniTAM [1] is one such framework developed at the University of Oxford. It uses innovative voxel hashing techniques for solving storage problem. The compute problem is solved by using either external GPU or CPU with various parallelization techniques. The authors of this abstract, as part of Technical Readiness (TR) activity for CCG, have analyzed the InfiniTAM framework for suggesting platform architecture to perform real-time reconstruction on client systems. Additionally they have identified few use-cases where 3D reconstruction will be needed. One basic use case is obstacle avoidance and will be demonstrated at the conference.

Solution

3D reconstruction has wide range of applications like VR/MR games, virtual trainings using simulators. This submission will demonstrate one such application called obstacle avoidance. While playing VR games, user put Head Mounted Displays and cannot see real world while playing. At present, VR head set providers do not take into account about possibility of user colliding with objects/humans present in vicinity. This causes safety concerns while using VR headsets. Using reconstructed model, we can give user better VR experience where he/she will be alerted whenever he/she is approaching an obstacle.

The demo script to be shown in the conference is as follows:

We will scan the room by capturing it using depth sensor camera like Microsoft Kinect as shown in Figure 1. InfiniTAM will use this data to generate mesh, which is a 3D representation of the room, as shown in Figure 2. This mesh is loaded to Unity game engine. While playing the game, user will be continuously tracked using tracker and as the user is approaching an obstacle he/she will be alerted by showing the obstacle as well as providing an alert message. Currently, the model is transferred to Unity game engine in offline mode but in the demonstration at the conference, it will be done in real time. It will also take into account addition and removal of objects in the scene. Also, the entire process, as shown in Figure 3 will be demonstrated in wireless manner at the conference.

Figure 1: Scene capture for 3D model construction.

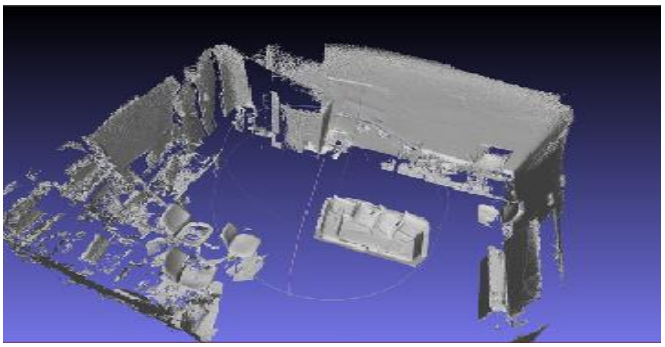

Figure 2: Reconstructed model to be inserted in unity.

Figure 3: Obstacle avoidance model pipeline

Current Obstacle Avoidance Demo can be seen at https://videoportal.intel.com/media/0_sxaufcjt

This demo was captured by us at our lab at SRR2, using Microsoft Kinect (Camera), HTC Vive (external Tracker). InfiniTAM was used for 3D reconstruction and NVidia graphics card was used for processing.

We will be showing similar demo using Microsoft Kinect / DS5 camera, in-house external tracker. InfiniTAM version which will do processing on CPU and internal graphics will be used by splitting reconstruction workload on CPU, internal GPU and VPU.

Key Takeaway

- 3D reconstruction is needed for giving better VR/MR experiences.

- Using InfiniTAM framework, large scale (room level) 3D reconstruction is possible now.
- Obstacle avoidance is one use case of 3D reconstruction where user can avoid collision with any real world object while playing VR content.
- Performing real time reconstruction using client platform (by making use of CPU and internal graphics) will give value add to Intel's virtuous cycle of growth

Self-Assessment

Criteria	Supporting Details
Scope	Capability of doing large scale 3D reconstruction makes VR/MR experience interesting and using CPU and internal graphics for this make our client platforms relevant to VR/MR world which in-turn accelerates Intel's virtuous cycle of growth.
Innovation	Provides an efficient large scale 3D reconstruction using CPU and internal graphics
Result	Obstacle Avoidance while playing VR content using 3D reconstruction
Interest	3D reconstruction is of growing interest for several usecases. It will inspire VR/MR software developers across CCG, PerC, VPG, NTG to come up with efficient usecases that can benefit by 3D reconstruction that uses CPU and internal graphics.

References

[1] Prisacariu, Victor Adrian; Kähler, Olaf; Cheng, Ming Ming; Yuheng Ren, Carl; Valentin, Julien; Torr, Philip H. S.; Reid, Ian D.; Murray, David W.,"A Framework for the Volumetric Integration of Depth Images",eprint arXiv:1410.0925,10/2014

[2] Obstacle Avoidance https://videoportal.intel.com/media/0_sxaufcjt