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RITK: The Range Imaging Toolkit – A Framework for 3-D Range Image Stream Processing

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Abstract

The recent introduction of low-cost devices for real-time acquisition of dense 3-D range imaging (RI) streams has attracted a great deal of attention. However, to date, there exists no open source framework that is explicitly dedicated to real-time processing of RI streams. In this paper, we present the Range Imaging Toolkit (RITK). The goal is to provide a powerful yet intuitive software platform that facilitates the development of range image stream applications. RITK puts emphasis on real-time processing of range image streams and proposes the use of a dedicated pipeline mechanism. Furthermore, we introduce a powerful and convenient interface for range image processing on the graphics processing unit (GPU). Being designed thoroughly and in a generic manner, the toolkit is able to cope with the broad diversity of data streams provided by available RI devices and can easily be extended by custom range imaging sensors or processing modules. RITK is an open source project and will be made publicly available at `http://www5.cs.fau.de/ritk`.

Categories and Subject Descriptors (according to ACM CCS): I.4.9 [Image Processing and Computer Vision]: Applications—D.2.13 [Software Engineering]: Reusable libraries—

1. Introduction

In the past, the acquisition of dense three-dimensional range imaging (RI) data was both tedious, time consuming and expensive, hence, hindering a widespread application. Lately, technological advances in RI sensor design have rendered metric 3-D surface acquisition at high resolutions (up to 300k points) and real-time frame rates (up to 40 Hz) possible. The advent of Microsoft's Kinect, with a mass market retail price of $150 a unit and more than 10 million sales within a few months, has caused a furor in the field of consumer electronics. With the introduction of affordable hardware, 3-D perception is gaining popularity and importance across a wide range of domains. In particular, we note an explosion of innovation in applications that benefit from the fact that state-of-the-art RI sensors deliver dense and dynamic range data streams in real-time. Among others, real-time capable RI sensors hold potential for human computer interaction, augmented reality, surveillance and security applications, biometrics [BWMH11] , medical engineering [MBWH11, BBHR11], or automotive and industrial applications [RMBD08]. Among range imaging sensors, structured light and Time-of-Flight (ToF) based devices are of particular interest and popularity. Unlike conventional RI approaches such as passive stereo vision, the recovery of depth from texture-less regions or repetitive patterns is not an issue with these novel modalities. Regardless of fundamentally different physical principles [GZ08, KBKL09], both technologies are capable of delivering dense and metric 3-D surface information at real-time frame rates. However, the acquisition and streaming of RI data typically implies an immense amount of data (in the scale of 500 MBit/s) to be propagated and processed. This poses a challenge in terms of throughput for subsequent data processing and analysis algorithms. Despite the advances in sensor technology, there exists no open source framework dedicated to real-time processing of RI streams.

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