Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 125 (2018) 124–131

Procedia Computer Science

www.elsevier.com/locate/procedia

6th International Conference on Smart Computing and Communications, ICSCC 2017, 7-8 December 2017, Kurukshetra, India

Construction of a 3D Map of Indoor Environment

Pradeep[a], Akanshu Mahajan[b], Varun Bharti[c], Harendra Pal Singh[d,*], Lalita Josyula[e], Pravesh Kumar[f]

[a,b,c,e]Sri Venkateswara College(DU), Benito Juarez Road Dhaula Kuan, New Delhi-110021, India
[d]Cluster Innovation Centre (DU), University Stadium G.C Narang Marg, New Delhi-110007, India
[f]Jaypee Institute of Information Technology, Noida 62, India

Abstract

This paper describes the construction of a 3D map of an indoor environment using the RGB-D camera (Microsoft Kinect V2.0). 3D mapping and localization have always been an intriguing topic in research and with the introduction of Microsoft Kinect sensor, the research has grown rapidly. In this paper, we propose a method to generate the 3D map of an indoor environment using the Microsoft Kinect version 2.0 sensor. The results obtained show an improvement over the previously used methods. We believe that this would contribute to many applications such as computer vision, robotics, home automation etc.

Peer-review under responsibility of the scientific committee of the 6th International Conference on Smart Computing and Communications.

Keywords: Kinect v2; 3D mapping; RANSAC; ICP; SIFT

1. Introduction

During recent years, the camera has become a unique sensor for mapping and localization. With the introduction of Kinect v2.0 sensor, the research in the field of Visual SLAM has grown exponentially. It is a pre-requisite to have precise knowledge of the walls, floors, objects etc., in an environment for the precise movement, tracking, and efficient localization. This requirement can be fulfilled by creating a 3D map of the environment. The 3D space information can be acquired from the cartesian coordinates and rotational angles. Therefore, we propose a method to construct the 3D map of the environment by aligning the point cloud data obtained from this information [1-5, 7].

During the early years, mapping approaches were mostly dependent on bulky and costly scanners. But with the introduction of cost-effective RGB-D cameras such as Microsoft Kinect, new opportunities have been created in this field. These cameras rely on the active stereo system and time of flight to generate the depth information at every pixel. The Point Cloud data, which consists of x, y, z position, pixel information and the normal at each point, is generated by combining the RGB data and the depth data.

* Corresponding author. Harendra Pal Singh. Mobile.: +91-9891910248;
E-mail address: harendramaths@gmail.com

1877-0509 © 2018 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the 6th International Conference on Smart Computing and Communications
10.1016/j.procs.2017.12.018

There are many approaches probabilistic mapping [7], feature based mapping [8], image intensity and shadow based mapping and Direct mapping that have been developed and used to create the 3D map of the unstructured environment using laser scanners and cameras by researchers and computer vision communities. But the proposed method only focuses on the literature which uses the RGB-D system for 3D mapping.

Many researchers have proposed different visual SLAM and 3d mapping system that rely on RGB-D cameras; Peter Henry [1]; Endres [2]; Stickler and Behnke [9], Stanimirovic [10], Thomas Whelan [11]. Kinect fusion algorithm of Newcombe and Izadi [20] is one of the most notable RGBD based 3D reconstruction systems. They used the depth data for the 3D scene reconstruction. One of the first 3D mapping and visual SLAM system was developed by Peter Henry [1] which is entirely dependent on the RGB-D data and feature matching. For building the pose-graph, the author used the technique called generalized ICP (GICP) [1] and an optimized surfel map was created. The use of pose graph optimization versus sparse bundle adjustment (SBA) is also studied which minimizes re-projection error. Recently, Thomas Whelan [11] proposed a volumetric based mapping of the large area. The author describes the use of fused volumetric reconstructed surface to achieve dense and accurate map. Felix Endres [2] also proposed a novel visual SLAM system using an RGB-D sensor. The system generates a 3D volumetric map of the environment and optimized the pose-graph using non-linear optimization. The Kinect fusion algorithm of Izadi and Newcombe and Izadi [20] uses only depth information from Kinect for 3D mapping and pose tracking based voxel grid. In this approach, the author only fuses depth information in real time and optimizes the map by tracking poses.

In this paper, we propose a feedback system that is used to generate the accurate 3D map of the indoor environment using the Microsoft Kinect version 2 camera. The paper is divided into the following sections: section 2 introduces the reader to the properties of Microsoft Kinect version 2 camera, section 3 gives a brief introduction to different types of techniques used in 3D mapping and describes the proposed algorithm by the author. Results and conclusion are covered in section 4.

2. Hardware and Software used

2.1. Microsoft Kinect:- The Microsoft Kinect v2 camera shown in Fig 1 consists of an RGB camera, depth sensor, microphone, infrared camera and the infrared projector. It captures a frame with a resolution of 1920×1080 and 512×424 for RGB and depth image respectively. The depth data is captured by IR camera with the frame rate of 30 fps [15, 17, 18]. Its operative range is from 50 cm to 4.5 meters [15, 17, 18]. The Kinect v2 uses optical time of flight technology for measuring the distance. [18].

$$d = \frac{c \times (Tr - Tc)}{2} \tag{1}$$

Here. Tr and Tc are the time of flight for emitted and received pulse and c is the speed of light.

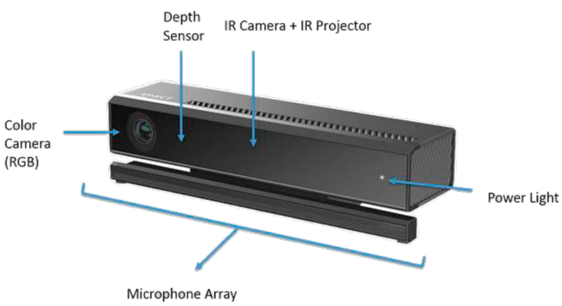

Fig. 1. The Microsoft Kinect V 2.0 sensor

Fig. 2. Depth image and RGB image captured by Kinect v2 camera

2.2 Laptop: - All the processing is completed using the Asus X541U i-3 7th generation 2.4 GHz Laptop.
2.3 Software: - The 3D mapping is completed using the MATLAB © software and for visualizing large dense map MeshLab © software is used