© 2016 IJSRSET | Volume 2 | Issue 5 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

3D Point Cloud/Map Generation Using DIY Board

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ABSTRACT

There are ample numbers of surveillance systems which can provide only 2D environment representation using video or images as output. However, if we can utilise the available technology of 3D point cloud generation to represent the surrounding in 3D it could create more accurate representation and depth perception of the surrounding. We are using Kinect/stereo cameras for input as well as ultrasonic rangefinders for collision avoidance. A point cloud is a set of data points in some coordinate system. In a three-dimensional coordinate system, these points are usually defined by X, Y, and Z co-ordinates, and often are intended to represent the external surface of an object. 3D scanners may create point clouds. These devices measure a large number of points on an object's surface, and often output a point cloud as a data file. The point cloud represents the set of points that the device has measured. As the result of a 3D scanning process point clouds are used for many purposes, including to create 3D CAD models for manufactured parts, metrology/quality inspection, and a multitude of visualization, animation, rendering and mass customization applications. Rangefinders for collision avoidance. A point cloud is a set of data points in some coordinate system. In a three-dimensional coordinate system, these points are usually defined by X, Y, and Z co-ordinates, and often are intended to represent the external surface of an object. 3D scanners may create point clouds. These devices measure a large number of points on an object's surface and often output a point cloud as a data file. The point cloud represents the set of points that the device has measured. As the result of a 3D scanning process point clouds are used for many purposes, including to create 3D CAD models for manufactured parts, metrology/quality inspection, and a multitude of visualization, animation, rendering and mass customization applications.

Keywords : 3D Point cloud, Kinect, Stereoscopy, Octomap

I. INTRODUCTION

A need to map a closed area, which may contain potential threat to human or some unmanned area which is small and closed, is increasing day by day. There are some solutions available but they are quite fewer. There are some systems which implement technologies like LiDAR[1] which are way too much costly to be implemented. There are ample number of surveillance systems which can provide only 2D environment representation using video or images as output. But If we can utilise the available technology of 3D point cloud[2] generation to represent the Surrounding in a 3D it could create more accurate representation and depth perception of the surrounding. Hence instead of deploying traditional 2D surveillance system, if we use available technology of 3D point cloud and Octrees we can generate more reliable representation. Mapping ofgiven area in 3D provides better understanding of an environment. Our system is intended to make those maps which are needed in real-world scenarios.In simple terms the need and objective of the project is to generate a 3D representation of the surrounding which will be used for more point clouds are used for many purposes, including to create 3D CAD models for manufactured parts, metrology/quality inspection, and a multitude of visualization, animation, rendering and mass customization applications.

II. METHODS AND MATERIAL

1. Literature Review.

A. A Real-Time Algorithm for Mobile Robot Mapping With Applications to

Three-dimensional models provide a volumetric representation of space which is important for a variety of robotic applications including flying robots and robots that are equipped with manipulators. In this paper, we present an open-source framework to generate volumetric 3D environment models. Our mapping approach is based on octrees and uses probabilistic occupancy estimation. It explicitly represents not only occupied space, but also free and unknown areas. Furthermore, we propose an octree map compression method that keeps the 3D models compact. Our framework is available as an open-source C++ library and has already been successfully applied in several robotics projects. We present a series of experimental results carried out with real robots and on publicly available real-world datasets. The results demonstrate that our approach is able to update the representation efficiently and models the data consistently while keeping the memory requirement at a minimum.**Multi-Robot and 3D Mapping.** An incremental method for concurrent mapping and localization for mobile robots equipped with 2D laser range finders. The approach uses a fast implementation of scan-matching for mapping, paired with a sample-based probabilistic method for localization. Compact 3D maps are generated using a multi-resolution approach adopted from the computer graphics literature, fed by data from a dual laser system. Our approach builds 3D maps of large, cyclic environments in real-time. It is remarkably robust. Experimental results illustrate that accurate maps of large, cyclic environments can be generated even in the absence of any odometric data.

B. 3D is here: Point Cloud Library (PCL).

With the advent of new, low-cost 3D sensing hardware such as the Kinect, and continued efforts in advanced point cloud processing, 3D perception gains more and more importance in robotics, as well as other fields. In this paper we present one of our most recent initiatives in the areas of point cloud perception: PCL (Point Cloud Library – **http://pointclouds.org**). PCL presents an advanced and extensive approach to the subject of 3D perception, and it’s meant to provide support for all the common 3D building blocks that applications need. The library contains state-ofthe art algorithms for: filtering, feature estimation, surface reconstruction, registration, model fitting and segmentation. PCL is supported by an international community of robotics and perception researchers. We provide a brief walkthrough of PCL including its algorithmic capabilities and implementation strategies.

C. An Efficient Probabilistic 3D Mapping Framework Based on Octrees.

Three-dimensional models provide a volumetric representation of space which is important for a variety of robotic applications including flying robots and robots that are equipped with manipulators. In this paper, we present an open-source framework to generate volumetric 3D environment models. Our mapping approach is based on octrees and uses probabilistic occupancy estimation. It explicitly represents not only occupied space, but also free and unknown areas. Furthermore, we propose an octree map compression method that keeps the 3D models compact. Our framework is available as an open-source C++ library and has already been successfully applied in several robotics projects. We present a series of experimental results carried out with real robots and on publicly available real-world datasets. The results demonstrate that our approach is able to update the representation efficiently and models the data consistently while keeping the memory requirement at a minimum.

D. Stereoscopy and the Human Visual System.

Stereoscopic displays have become important for many applications, including operation of remote devices, medical imaging, surgery, scientific visualization, and computer-assisted design. But the most significant and exciting development is the incorporation of stereo technology into entertainment: specifically, cinema, television, and video games. In these applications for stereo, three-dimensional (3D) imagery should create a faithful impression of the 3D structure of the scene being portrayed. In addition, the viewer should be comfortable and not leave the experience with eye fatigue or a headache. Finally, the presentation of the stereo images should not create temporal artifacts like flicker or motion judder. This paper reviews current research on stereo human vision and how it informs us about how best to create and present stereo 3D imagery. The paper is divided into four parts: (1) getting the geometry right, (2) depth cue interactions in stereo 3D media, (3) focusing and fixating on stereo images, and (4) how temporal presentation protocols affect flicker, motion artifacts, and depth distortion.

E. Resolution adjustable 3D scanner based on using stereo cameras

This paper addresses a stereo-based 3D scanner system, which is able to acquire various resolution range data. The system consists of stereo cameras and one slit laser. In each stereo image pair, we cast one laser stripe on the surface of object, and analyze their disparities for determining their depth values. Utilizing a super-sampling filter, the sub-pixel features are generated for enhancing the native resolution of CCD component. In this system, we use one slit laser for sweeping the surface of objects and generating correspondences under the epipolar constrain. Since the correspondences are generated by the positions of the cast stripes, their resolution is controllable.

F. Stereoscopic Scanner in Quality Control.

A very simple method of making stereoscopic image pairs from small objects by means of flatbed scanners has been recently developed. Due to the non-parallel optics of modern flatbed scanners using CCD-elements, objects can be scanned with slightly different viewing angles by simply putting them on different lateral positions on the glass surface. Because of the high resolution and the good optical properties of modern flatbed scanners, this method is particularly well suited for applications in quality control. After a brief description of the principle, a new low cost stereo / 3D scanner based on this principle is presented.

III. RESULTS AND DISCUSSION

Proposed System

Our system will be mounted on a robot. This robot will move from boundary to boundary of closed area. It will have a sensor, most probably stereo cameras or Kinect sensor to detect depth information of area. [2][4] From this information, the raspberry pi board which is programmed with libraries and some scripts, will generate equivalent 3D dataand pre-processed information and will show output to some display device. As discussed previous chapter, these sensors are slower to detect obstacle. Hence to detect obstacle, we need ultrasonic range finder, which will continuously be running and if robot is near some obstacle, it will trigger obstacle function, which will change course of robot's path. [2][4] In continuance with that, a plotting function will be running which will be keep plotting the point cloud information of a plane.

Algorithm for navigation:

Step 1: Deploy at the end/boundary
Step 2: Save Initial position.
Step 3: Scan the area/view.
Step 4: Save unprocessed data and check for next position/obstacle.
Step 5: Repeat Step 4 until all the area has been scanned and return to the Initial position.

Algorithm for scanning:

Step 1: Detect boundary.
Step 2: Scan and store gathered data from sensors in appropriate data types.
Step 3: If obstacle is detected change course/path and go to step 1 else go to step2
Step 4: Repeat step 3 until reached end of the boundary.
Step 5: Call navigation method to navigate up to the next boundary.

Functionalities by different parts of hardware

- **Sensors**:
  Gather information from the surrounding environment and transfer it to processing unit using various GPIO pins. Sensors may include pair of cameras, ultrasonic sensors, Kinect sensor and other system specific sensors.
- **Processing unit:**
  The main processing unit may switch between a standalone system or on-board processing provided by Raspberry Pi i.e. 1Ghz processor and 1 GB ram. If standalone system is used to process the information, it will be transferred over the Wi-Fi enabled network.
- **Display devices**:
  Display devices will be used to immediate representation of information or to review pre-processed information from another instance.
- **Motors and Printed Circuits:**
  Motors and controlling PCBs will allow precise and controlled manoeuvrability to our system.

IV. CONCLUSION

Hence, we conclude that the contents that are important to project are studied and a project report has been made. Our goal is to implement a working system, which is capable of generating a 3D point cloud representation of the enclosed environment. From the implementation of the above project, we can conclude that the 3D representation can easily replace the conventional surveying techniques with more accurate information gathering and processing. Future of this project may allow users to generate editable poly, high-resolution 3D representation that can be imported into 3D map manipulation software for further processing. Accuracy can be improved of information gathered and produced output by using more advanced sensors, processing hardware-processing techniques. Eg. LiDAR, High End stereoscopic camera which can be integrated in other systems to serve different needs.

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