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3D Point Cloud/Map Generation using DIY Board

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ABSTRACT: There are ample number of surveillance systems which can provide only 2D environment representation using video or images as output. But we have utilise the available technology of 3D point cloud generation to represent the surrounding in a 3D it could create more accurate representation and depth perception of the surrounding. We have used Kinect for input as well as Web Camera for Telecasting. 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 coordinates, and often are intended to represent the external surface of an object. Point clouds may be created by 3D scanners. 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

I. Introduction

The 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.

Problem statement: "To develop a system which can make 3d models of some closed area."

There are ample number of surveillance systems which can provide only 2d environment representation using video or images as output. But we have utilised the available technology of 3d point cloud generation to represent the surrounding in a 3d it can create more accurate representation and depth perception of the surrounding. To explore some an unmanned area directly is quite dangerous. hence instead of directly deploying humans, if we first get to know the area, it can be analysed better. Mapping to given area in 3d makes better understanding of 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 accurate depth perception and representation of the environment as a 3-dimensional map. This project is also be used to generate a reliable representation of area inaccessible to its human counterparts while surveillance.

II. Related work

i) RTAB : RTAB-Map (Real-Time Appearance-Based Mapping) is a RGB-D Graph-Based SLAM approach based on an incremental appearance-based loop closure detector. The loop closure detector uses a bag-of-words approach to determinate how likely a new image comes from a previous location or a new location. When a loop closure hypothesis is accepted, a new constraint is added to the map's graph, then a graph optimizer minimizes the errors in the map. A memory management approach is used to limit the number of locations used for loop closure detection and graph optimization, so that real-time constraints on large-scale environnements are always respected. RTAB-Map can be used alone with a hand-held Kinect or stereo camera for 6DoF RGB-D mapping, or on a robot equipped with a laser rangefinder for 3DoF mapping.

ii) Hector Slam: Hector slam contains ROS packages related to performing SLAM in unstructured environments like those encountered in the Urban Search and Rescue (USAR) scenarios.

iii) OctoMap: Octomap Library implements a 3D occupancy grid mapping approach, providing data structures and mapping algorithms in C++ particularly suited for robotics. The map implementation is based on an octree and is designed to meet the following requirements:

   a. Full 3D model. The map is able to model arbitrary environments without prior assumptions about it. The representation models occupied areas as well as free space. Unknown areas of the environment are implicitly encoded in the map. While the distinction between free and occupied space is essential for safe robot navigation, information about unknown areas is important, e.g., for autonomous exploration of an environment.
   b. Updatable. It is possible to add new information or sensor readings at any time. Modeling and updating is done in a *probabilistic* fashion. This accounts for sensor noise or measurements which result from dynamic changes in the environment, e.g., because of dynamic objects. Furthermore, multiple robots are able to contribute to the same map and a previously recorded map is extendable when new areas are explored.
   c. Flexible. The extent of the map does not have to be known in advance. Instead, the map is dynamically expanded as needed. The map is multi-resolution so that, for instance, a high-level planner is able to use a coarse map, while a local planner may operate using a fine resolution. This also allows for efficient visualizations which scale from coarse overviews to detailed close-up views.
   d. Compact. The map is stored efficiently, both in memory and on disk. It is possible to generate compressed files for later usage or convenient exchange between robots even under bandwidth constraints.

iv) Kinect Technology: Kinect is a line of motion sensing input devices by Microsoft for Xbox 360 and Xbox One video game consoles and Windows PCs. Based around a webcam-style add-on peripheral, it enables users to control and interact with their console/computer without the need for a game controller, through a natural user interface using gestures and spoken commands.

v) The project is based upon above four module.

III. PROPOSED SYSTEM

Implementation of this entire project is done on a DIY board that is raspberry pi. Raspberry pi is the heart and soul of the entire project . The project is basically a robot and driven by separate entities. Robot is mainly used for a specific area where no man can be deployed or a person cannot enter that specific area. It roams throughout the area and generates a 3dimensional map. This 3D map is generated with the help of kinect sensors.

IV. SIMULATION RESULTS

The 3D map is generated from Kinect sensors which are displayed by RTAB-map. With the help of RTAB map a 3D map is generated. RTABis a previously implemented technology which is installed on Robot Operating System(ROS). The following output is displayed on software for output display purpose called as MeshLab.
The above images are 3D scan of Living Room. There is breakage between the walls because there was an obstacle between wall and sensors. Point cloud represented in MeshLab are exported output of Rtabmap in .pcd file format (Point Cloud Data). Field of vision represents maximum peripheral vision of the viewer while viewing the output in MeshLab.

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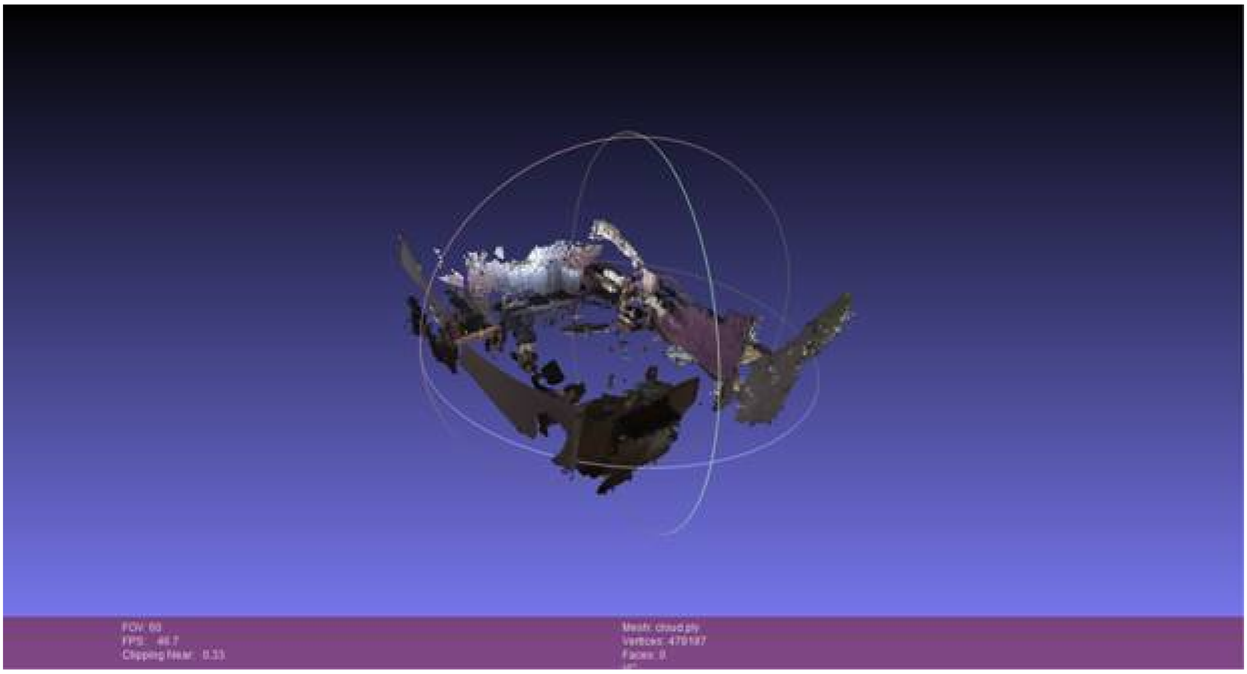
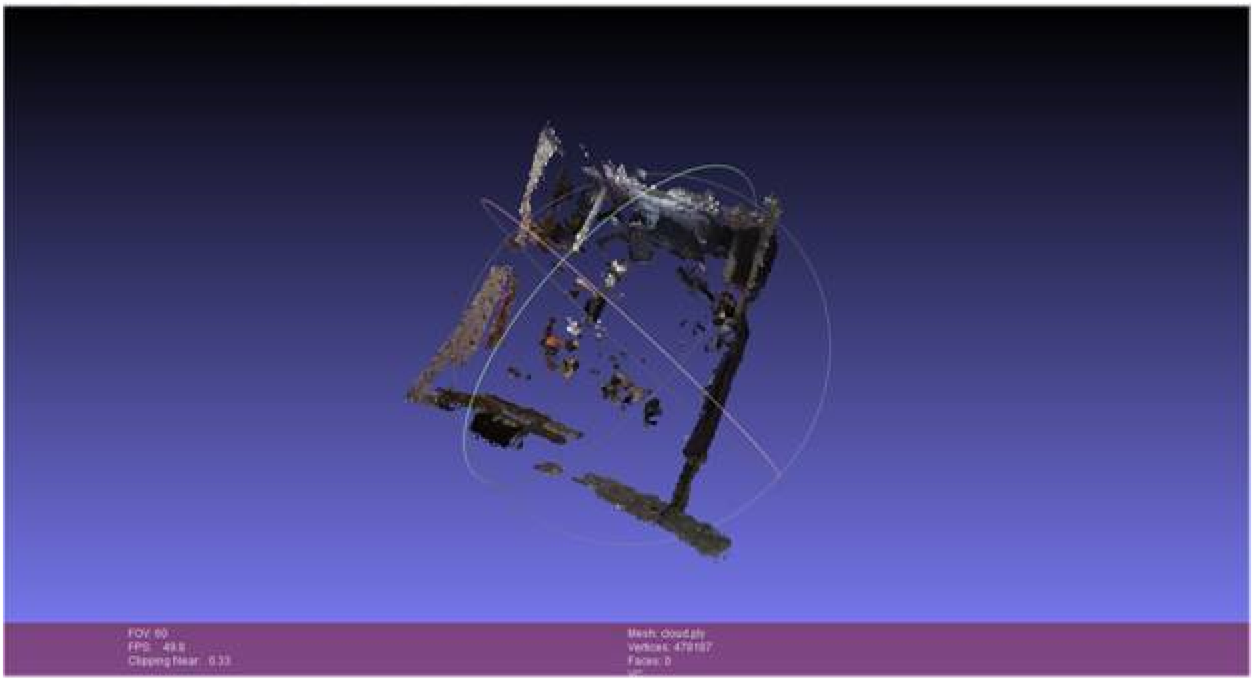


Fig(a): -Side View of Scanned Environment in MeshLab, Field of vision(FOV) :60, Frame per second(FPS):45.7,Vertices:478187 and 0 Faces



Fig(b): -Top View of Scanned Environment in MeshLab, Field of vision(FOV) :60, Frame per second(FPS):49.8,Vertices:478187 and 0 Faces

The above images are 3D scan of Living Room. There is breakage between the walls because there was an obstacle between wall and sensors.

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V. CONCLUSION AND FUTURE WORK

Our goal of implementing a working system which is capable of generating a 3D point cloud representation of the enclosed environment is accomplished. 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 which 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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