Original Article

Recognition of Intent Using Light Detection and Ranging

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Abstract

Object detection has been a prominent area of research since the introduction of machine learning. Light Detection and Ranging (LIDAR) is a new high-resolution earth space information technology with features such as a fast data production cycle, moderate climate impact, and high degree of automation and so on. These sensors form a host of information points that can be used to detect barriers in their environment during their short scanning cycles. These sensors have short scanning cycles that create many points with data that can be used to recognize potential hazards in the area. Although data collection, key findings, and filtering of sound or road markers are difficult tasks, they must be reliable and accurate. This paper represents a development of a proto-model of a 3-D LIDAR imaging system for short-range military and surveillance applications by using point cloud measurements.

Keywords: LIDAR, Object Detection, Point Cloud, 3-D LIDAR Imaging.

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INTRODUCTION

Surveillance in military-based areas has always played an important role in defence. Due to poor night vision by human naked eye, there were numerous incidents in the military that resulted in significant human and property loss because we were unable to identify them and take appropriate action at an early stage. Our project will not only avoid this loss but also helps us from distinguish between our troops and other people.

Laser technology has advanced significantly in terms of science and engineering, allowing it to be employed in a variety of commercial, industrial, medical, and scientific applications. Photography, holography, spectroscopy, surgery data storage, and a variety of other fields have all benefited from lasers. It uses the stimulated emission phenomenon to create a coherent optical beam with a wide range of functions for a variety of applications. LIDAR's work in much the same way as radars because they bring simple pulses to the target and determine the distances it takes for the pulses to return. The ability to detect hidden objects such as leaves, trees, and even a hidden net is one of the main benefits of a LIDAR [1]. It is a method developed by military scientists decades ago to identify satellites but is now being used for a variety of purposes [2]. LIDAR is an important source of United States Army as it is more sensitive to the movement and movement of unknown objects than RADAR and SONAR.LIDAR is used to map the terrain of conflict zones in order to better prepare our troops for the battlefield.

A small number of research organizations at the national level have been working on the design and development of LIDAR systems, primarily for atmospheric studies and environmental monitoring [3]. All of these LIDAR systems are primarily non-imaging in nature, but they do provide range information based on time-of-flight measurements. They are based on direct detection of scattered intensity to characterize various atmospheric properties and measurement of minor gas and pollutant concentrations in the atmosphere [4].

The ability to recognize objects in photographs has greatly improved. Several methods for extracting items from the LIDAR point cloud have also been developed. Although there are some similarities between the two approaches, there are two notable differences. First and foremost, the image is a dense image of knowledge. On the other hand, the LIDAR point cloud is substantially smaller. Second, an image is a two-dimensional representation of anything. The LIDAR cloud point, on the other hand, is a three-dimensional image. As a result, cloud-based acquisition methods based on LIDAR points and image lines are not necessarily the same. LIDAR has created a new paradigm in 3-D imagery, which is a disruptive technology that can be applied to automotive (AV) vehicles, smart homes, smart security, robots, Drones, and other 3D-recognizable devices.

The LIDAR 3-D imaginable produces cloud points in real time about a circle around an area intended to be scanned [5].

The rest of the paper is organized as follows. Section II explained a literature survey, Section III provides the implementation methodology, features and applications, the simulation results are discussed in Section IV and Section V conclusion of a 3-D LIDAR imaging system.

Related Work

In [6] LIDAR technology delivers a novel data source and three-dimensional location points in the form of a cloud point depending on data acquisition. It's easy to locate. Data from LIDAR is integrated with data from the aircraft, making the data more versatile. How to prepare for other test materials, such as mapping, and their impact on local area data for key performance areas, such as DEM application, design, and high-tension transmission line analysis, survey and open space construction, and so on.

In [7] In this paper, we look at the output of the Point Pillars 3D network based on the LIDAR data from the scenes database. Three types of items are available (car, pedestrian, bus).

In [8] the findings show that increasing the amount of LIDAR sweeping improves accuracy. greatly enhances the performance of the 3D object detector. Additional factors have a significant impact on performance. By providing a training database, the number of items with a label.

In [9] The results were obtained separately for each class divider, as well as the combined filtering method used to maximize system performance. This integrated division approach can be thought of as a functional Bayesian framework that employs a whole system to integrate the background opportunities for each class segment in the most comprehensive way feasible. Preliminary tests on the realities of urban roads show that the system can detect and distinguish pedestrians and vehicles in different locations, shapes, sizes, and colors with a maximum accuracy of up to 20 meters [10].

Implementation Methodology

The LIDAR system first collects the data points of the area that is scanned. This point data includes the information of the LIDAR system as well, so in the next step we remove the point data of the LIDAR system. Later a separation of the ground plan i.e., the ground and the objects on it is done. After the separation the system color codes the different objects in the scanned area. This eventually makes it easier to identify the data and the corresponding objects in it. The figure 1 represents the flowchart of object detection. This is explained in much more details in results section.

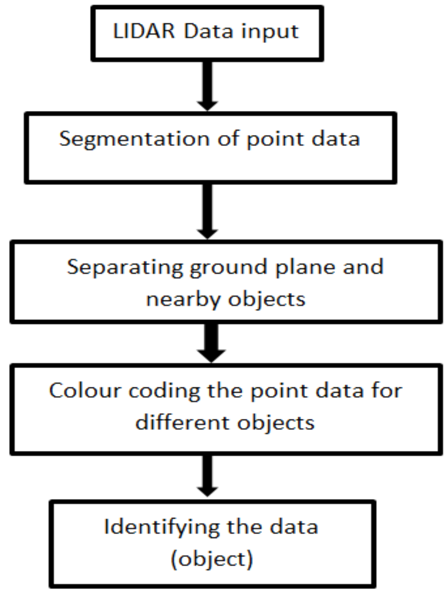

Figure 1: Flowchart of object detection

Features

1. Cover the range from 0 to at least 1 km in short range military and surveillance system
2. Identify a person in hideout
3. Function under 4 mm/ hour rain conditions
4. Identify targets like vehicles, tanks, radars and missile launch sites
5. Will be able to operate through:
    - Camouflage
    - Foliage
    - Breeze, smoke, fog, field dust etc.
    - Cloud, rain, Sea haze etc.

Applications

(a) Military operations: Can be used for
- Detection (friends, enemies, and neutral organizations)
- Border guards, and terrorist protection.
- Property protection
- Sniper detection
- Drone detection (remote control fields)

(b) Border control: An active night-time laser scanner helps control the boundary by allowing soldiers to see clearly in a variety of light conditions. This feature is necessary for the military to determine whether a person is in charge or not.

(c) Police applications and law enforcement: Police departments are increasingly being tasked with combating terrorism, vandalism and unplanned violence. Active laser range - portable and gateless photographic systems are very effective in increasing police and public safety. Systems can be built for both short-term interventions and long-distance surveillance.

(d) Aerial systems: A functional scope image system, integrated into multiple spectral imaging techniques, will enable a variety of applications that affect the wind, including linearization, among others.

Simulation Results and Discussions

1. Interpreting LIDAR data

In this sample the LIDAR data was recorded in PCAP format using the Velodyne® HDL32E sensor. A 3-D point cloud is created for each scan. The performance of the sensor processing pipe depends on the successful processing of this data using rapid identification and search. The MATLAB point cloud object is used to achieve this efficiency, which organizes the data using the K-D tree data structure.

For every LIDAR scanner, Velodyne File Reader generates a unique point Cloud. X, Y, and Z-point connectors with meters are stored in point Cloud's Location, which is the M-by-Nby-3 matrix. Intensity point Cloud's attribute retains the firmness of the point. We used the MATLAB object PC player to visualize the cloud data of the streaming point and specify the region closest to the vehicle to be displayed. Following that, Figure 2 shows that how to differentiate between space planes, ego cars, and neighboring obstacles.

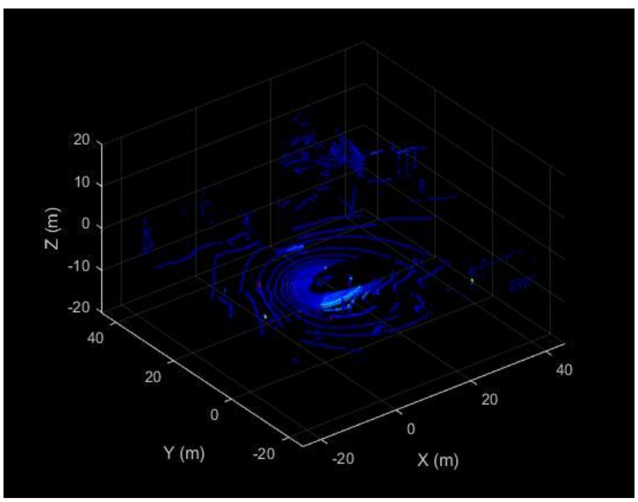

Figure 2: A single frame of the LIDAR point cloud is displayed

2. Ego Vehicle Segmentation

Because the LIDAR is situated on top of the car, the point cloud may comprise points on the roof or hood that belong to the vehicle. To segment these points, you'll need to know the vehicle's dimensions as well as the sensor's location in vehicle coordinates.

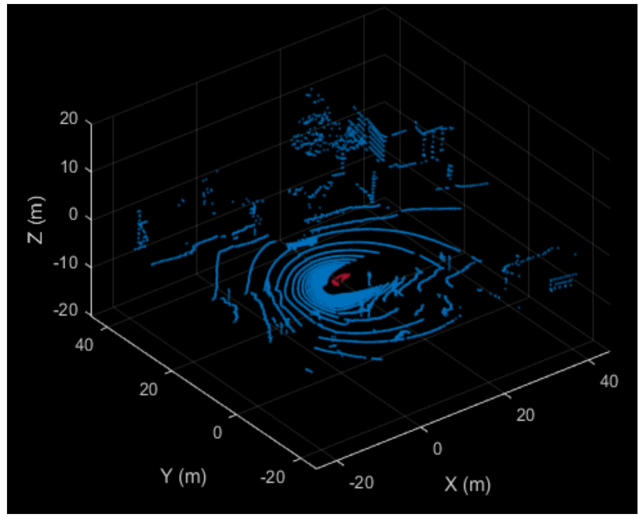

Figure 3: The ego car generates display points

Figure 3 shows the results for one data frame. This stage is accessible due to the size of the vehicle and the location of the sensor.

3. Ground Plane and Nearby Obstacles Segmentation

In order to locate barriers from the LIDAR data, we first used the segment Ground from LIDAR Data method to separate sub-plane points. Using an algorithm for connected segments, this function labels low points in the exponential image. Figure 4 shows the result of different colors are used for the elements formed by the appearance of the road and the ego car, as well as unmarked points that can be made of flexible objects such as pedestrians, cars, bicycles, or vertical objects such as buildings and trees.

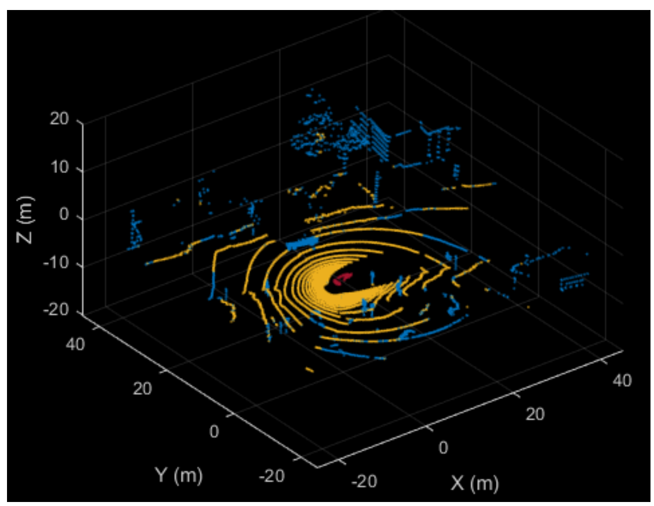

Figure 4: To visualize the road, the ego car, and the unnamed points, different colors are used

The next step is to break down the interdependent barriers by looking at all the points within your areas of interest near the ego car that is not part of the lower or ego car. The number of routes in the route or the sensor's range can be used to calculate this region of interest online.

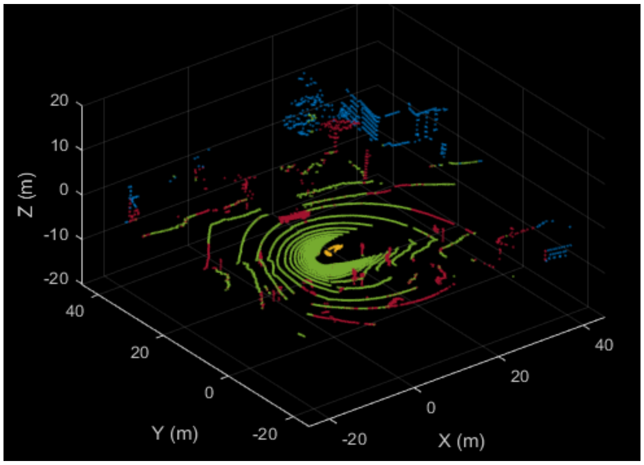

Figure 5: Nearby obstacles are indicated in red

Once a single-degree cloud processing pipeline has been established, it can be used to analyze scans taken while driving or the sequence of recorded data in each step. Nearby obstacles are shown in figure 5.

4. Objects of Interest are Identified and Marked

Obstacle points within the ego car interest rate can be integrated and identified using 3D binding boxes that combine the acquired object with the other data needed by the tracker, such as the time of detection and measurement uncertainty.

Conclusions

Due to its high accuracy and precision, LIDAR surpasses existing RADAR and SONAR technologies. LIDAR technology provides a novel data source and three-dimensional spatial points in the form of a point cloud. It is simple to collect LIDAR data using an aircraft, which will alter the data processing method of several surveying and mapping products and have an impact on related basic science application areas.

We first showed how we can preview cloud points to generate regular tracking acquisitions. We demonstrated how to use the JPDA tracker in the second phase of the study. Using the LIDAR sensor and IMM filter to track items create code C from the algorithm, and check that it works results.

Future Extension

(a) It can be upgraded to work with other commendable systems such as thermal scanners, virtual cameras, and infrared cameras, among others. This will facilitate the use of data from different sensor systems on real time basis.

(b) We can upgrade the model for long range night vision by using range gated imaging technique.

(c) Can be upgraded to not only recognize the intent but also trace the intent.

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