Robust Virtual Scan for Obstacle Detection in Urban Environments

He Mengwen[1,3], Eijiro Takeuchi[1], Yoshiki Ninomiy[2,3], and Shinpei Kato[1,3]

[1]Graduate School of Information Science, Nagoya University
[2]Institute of Innovation for Future Society (MIRAI), Nagoya University
[3]JST/COI, Nagoya

Objectives

- Develop a robust and real-time algorithm to transfer the point-cloud captured by a 3D LiDAR (e.g. Velodyne) to a 2D virtual scan (VScan) to represent the obstacles around the ego-vehicle. (Fig. 1)
- Handle the inefficiency of general VScan methods on conditions of sloped roads (e.g. steep ramps), small objects (e.g. road curb), and overhung obstacles (e.g. barrier gate). (Fig. 2)

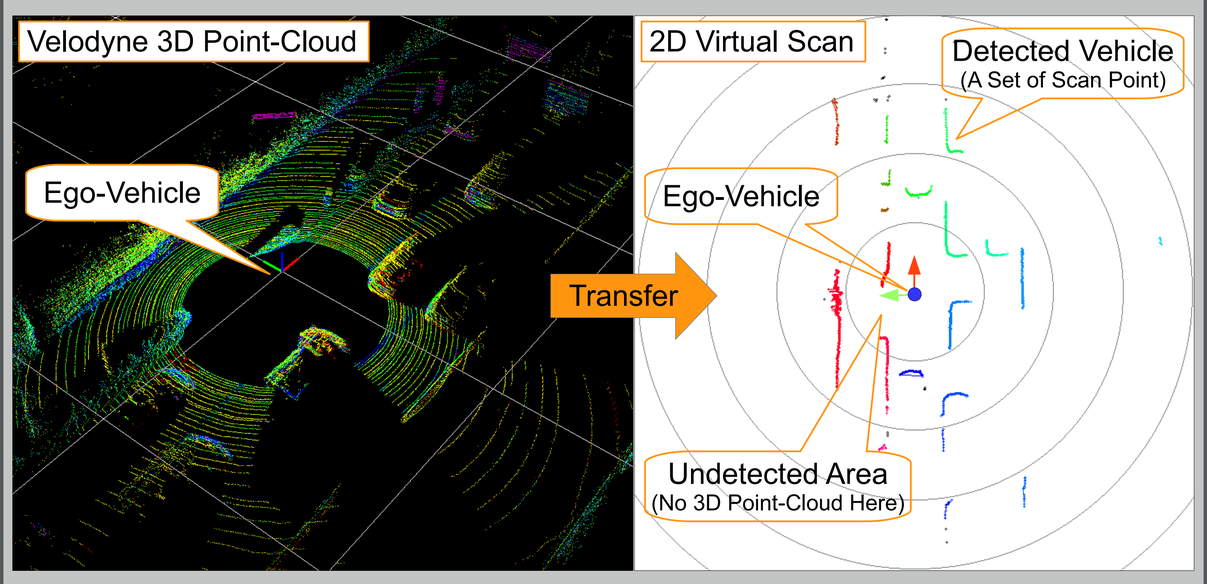


Figure 1: Transfer the 3D point-cloud to a 2D virtual scan. The word "virtual" means that the scan is not from a real 2D LiDAR but from the input 3D point-cloud; therefore, we can find an undetected area in this figure, which is a dead zone for our vehicle-borne Velodyne.

Figure 2: Challenging scenarios for general VScan methods. The road surface of steep ramp would be falsely detected as an obstacle; The road curb and barrier gate would be ignored as free space.

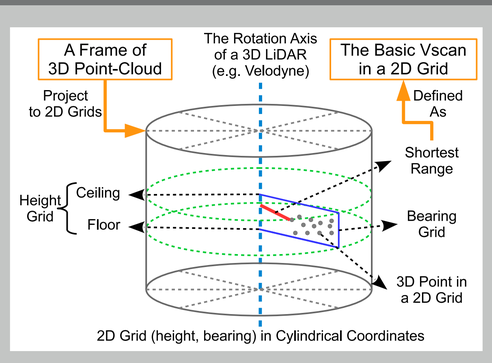
Introduction

- Many intelligent vehicles rely on LiDARs for obstacle detection as well as localization and mapping.
- The 3D LiDAR, e.g. Velodyne, can fully scan the real world at 10 Hz producing nearly 100,000 points per frame; however, directly processing a frame of point-cloud is always time-consuming.
- The 2D LiDAR, e.g. SICK or Hokuyo, can horizontally scan the surrounding and briefly represent the obstacles as an array of range values; however, it may falsely detect sloped road surfaces as obstacles, and it cannot properly detect low or overhung obstacles.
- The VScan is also an array of range values from a 2D compact transformation of point-cloud. Meanwhile, we developed a robust and real-time VScan algorithm to handle the sloped road, low objects and overhung obstacles. Therefore, the VScan is suitable for rapid further processing in a complex urban environment.

Contributions

- A new data structure called *Basic VScan Matrix* (BVSM) represents point-cloud around the ego-vehicle.
- A *Simultaneous Road Filtering and Obstacle Detection* algorithm works on top of BVSM for robust VScan generation.
- A *Sorted Array based Acceleration Method* enables real-time VScan generation.

Method Description



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Algorithm Description

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Experiment Results

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Figure 3: Figure caption

Conclusion

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Main References

Acknowledgments

- This research is supported by the Center of Innovation Program (Nagoya-COI: Mobility Society Leading to an Active and Joyful Life for Elderly) from Japan Science and Technology Agency.

Contact Information

- Web: http://www.coi.nagoya-u.ac.jp
- Email: mailto:alexanderhmw@gmail.comalexanderhmw@gmail.com
- Phone: +81-052-789-4841