GPU–based Dense Mapping for Aerial Robotics

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Abstract

Dense mapping in real–time is among the most critical functionalities that an aerial robot should possess in order to be able to conduct applications useful to the society. Although some solutions exist, most of them rely on structured–light sensors and can operate only in very limited distances and appropriate light conditions. Using a stereo camera for this purpose can lead to a more versatile framework but achieving equal levels of data density in real–time and at comparable update rates is a major challenge. This project aims to examine the use of embedded systems with GPUs and stereo camera systems in order to achieve this goal.

1 Description of Work

Three–dimenstional vision sensing that can lead to highly dense mapping of the environment is a key feature of aerial robotics if such system are to be able to execute high–fidelity inspection operations. To that day, the international state–of–the–art does not include a solution that can be lightweight, power efficient and be able to provide very dense point clouds in real–time and high update rates. Solutions for lightweight systems exist mostly around structured–light sensors and are unable to operate in long distances and bright or dark light conditions.

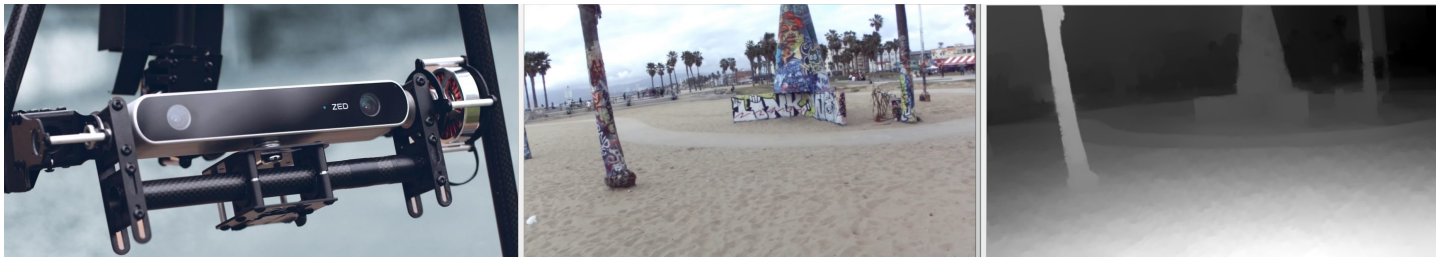

Figure 1: Stereo camera depth sensing based on a desktop computer.

As a camera sensor is much more versatile and with very low cost, our goal is to develop on cutting–edge embedded systems that integrate top–notch Graphics Processing Units (GPUs) and integrate stereo camera systems onto small aerial robotics. Our goal is to be able to conduct autonomous missions that lead to high fidelity reconstructions of 3D. Once a perception module such the one described in this project will be developed, the next step will be to integrate as a part of the autonomous navigation and operation pipeline of our aerial robots.

2 Tasks and Milestones

List of Tasks

- **T1:** Learn and understand the basics of Computer Vision
- **T2:** Interfacing of the Stereo sensor
- **T3:** Development of the depth sensing system as a ROS package (coding on the GPU of laptop)
- **T4:** Transfer to embedded system with GPU (Tegra)
- **T5:** Demonstration and Evaluation
- **T6:** Documentation

List of Milestones

- **M1:** Integration and Interfacing of the camera system, ***M3***
- **M2:** ROS package for depth sensing, ***M5***
- **M3:** Embedded Depth Sensing System and Evaluation report, ***M6***

3 Requirements

1. Very independent, but a good team player
2. Experienced C++ programmer
3. Prior knowledge of computer vision is a plus
4. Experience with the Robot Operating System is a plus
5. Experience with embedded systems is a plus
6. Experience with GPUs is a plus

4 Supervision

This project is supervised by:

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