Promotionsthema

2019-10-21

Jingwei Zhu

Analysis of urban scenes by fused thermal infrared images and LiDAR point clouds

With the rapid urbanization, demands for automatic analysis, the complex urban scenes are dramatically increased for tasks like environment monitoring. Due to the dynamic changes of the urban scenes and the complexity of the artificial and natural objects, using a single data source can hardly get satisfying outputs. Fusing thermal infrared images and LiDAR point clouds could be a solution for (i) energy inspection and leakage localization for the buildings and the pipelines, and (ii) material distinction for objects with textures or covers.

Benefiting from the decrease of the price of uncooled thermal sensors and the more straightforward operation of devices (e.g., cameras), thermal images are widely used in a wide variety of applications for the interpretation task. Traditional applications utilize normally a series of thermal images, which cannot discern the occluded objects and required highly overlapped multi-view images for analysis. Moreover, using merely thermal infrared images can hardly express the thermal information of 3D objects in all aspects.

In this work, the thermal infrared images and the LiDAR point clouds of the urban areas, which are acquired from mobile platforms, will be exploited. Images and point clouds will be fused to generate the 3D thermal point clouds containing objects such as buildings, roads, parking cars, and trees, which could be further utilized for the scene interpretation with enhance information. The aim of the research is to analyze the thermal states of the objects (e.g., buildings or parking cars) in the urban areas by 3D thermal point clouds. To achieve this goal, the research will involve following essential questions:

- ❑ How to achieve point-level matching and integration of the thermal images and the point clouds? The 3D thermal point clouds will be generated firstly from the sequences of thermal infrared images. The coarse point cloud will be roughly co-registered to LiDAR point clouds via the extracted corresponding keypoints. The relationship between thermal infrared images and point clouds will be explored by corresponding keypoints pairs for data fusion.

- ❑ How to conduct structure-level matching and integration of thermal images and point clouds? Compared to points, lines and planes are more robust features for aligning objects and estimating poses. Therefore, we will utilize lines and planes as fundamental elements to form the structures. The alignment method will be investigated by comparing similar structures between thermal infrared images and the LiDAR point clouds. After that, a fusion method dealing with thermal information from multi images will be investigated.

- ❑ How to classify man-made objects (e.g., buildings or parking cars) enhanced with thermal states in urban areas? Based on 3D thermal point clouds, a classification will be conducted to label objects in the scenes. Besides, we will investigate a method to find potential hidden structures in buildings, such as pipelines, or locate the potential energy leakage for the automatic alert.

Expected results are two-folds. Firstly, the 3D thermal point clouds of the objects (e.g., buildings or parking cars) in urban areas will be generated. Approaches and algorithms to automatic fuse thermal infrared images and LiDAR point clouds will be developed and verified. Then, a classification will be conducted to label the objects and analyze their thermal states. Methodology to detect the hidden structures inside the buildings and the abnormal phenomenon will also be investigated. Besides, the RGB images and benchmark data may be used for evaluation.