STheReO: Stereo Thermal Dataset for Research in Odometry and Mapping

Seungsang Yun[1], Minwoo Jung[1], Jeongyun Kim[1], Sangwoo Jung[1], Younghun Cho[2], Myung-Hwan Jeon[3], Giseop Kim[4] and Ayoung Kim[1*]

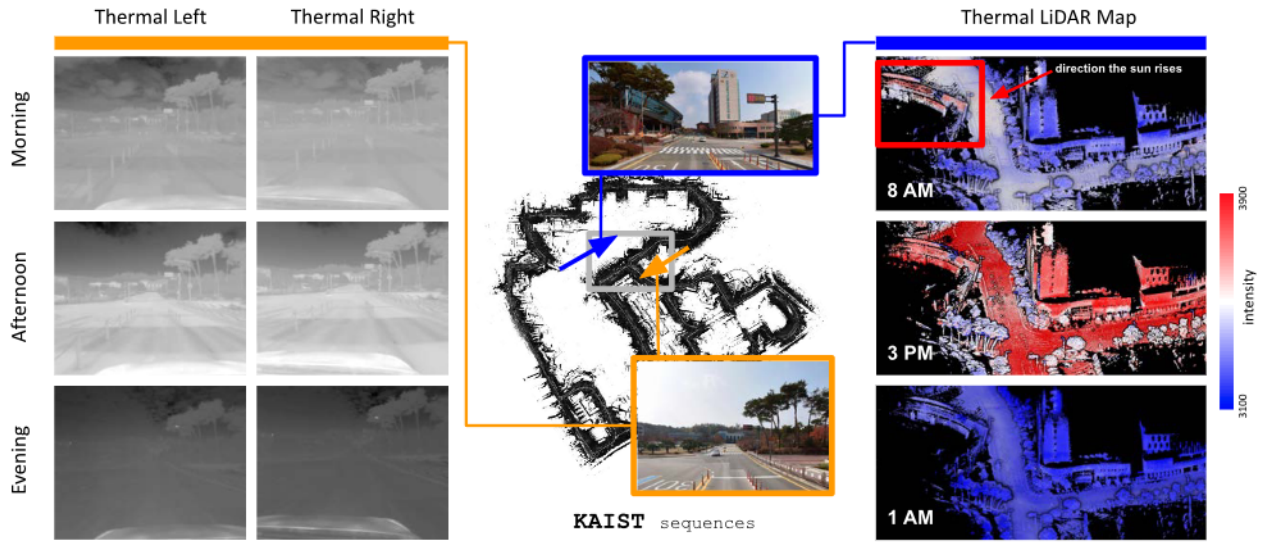

Fig. 1: The stereo thermal image pairs (left) and the thermal 3D point cloud maps (right) for three different times for our KAIST sequences are visualized. The 3D point cloud map at the middle is constructed using our SE(3) baseline trajectory. Our STheReO dataset provides stereo thermal camera images with multiple commonly used sensors such as inertial measurement unit (IMU), RGB camera, and light detection and ranging (LiDAR). Using our bundle of sensors and baseline trajectories, we encourage exploring stereo thermal camera-based SLAM researches that can be used for robotic applications such as thermal-LiDAR mapping as in the right plots and Fig. 7. From the thermal LiDAR map (right), we can see the 3D temperature variation within a day when a particular building (red box) in the morning heats up faster than others as it faces the direction of the sunrise. We can also see the distinct thermal intensity gaps among different times for the same site.

***Abstract*— This paper introduces a stereo thermal camera dataset (STheReO) with multiple navigation sensors to encourage thermal SLAM researches. A thermal camera measures infrared rays beyond the visible spectrum therefore it could provide a simple yet robust solution to visually degraded environments where existing visual sensor-based SLAM would fail. Existing thermal camera datasets mostly focused on monocular configuration using the thermal camera with RGB cameras in a visually challenging environment. A few stereo thermal rig were examined but in computer vision perspective without supporting sequential images for state estimation algorithms. To encourage the academia for the evolving stereo thermal SLAM, we obtain nine sequences in total across three spatial locations and three different times per location (e.g., morning, day, and night) to capture the variety of thermal characteristics. By using the STheReO dataset, we hope diverse types of researches will be made, including but not limited to odometry, mapping, and SLAM (e.g., thermal-LiDAR mapping or long-term thermal localization). Our datasets are available at https://sites.google.com/view/rpmsthereo/.**

[1]S. Yun, M. Jung, J. Kim, S. Jung, and A. Kim are with the Depart. of Mech. Eng., SNU, S. Korea [seungsang, moonshot, jeongyunkim, dan0130, ayoungk]@snu.ac.kr

[2]Y. Cho is with the Depart. of Civil and Env. Eng., KAIST, S. Korea lucascho@kaist.ac.kr

[3]M. Jeon is with the Robotics Program, KAIST, Daejeon, S. Korea, myunghwan.jeon@kaist.ac.kr

[4]G. Kim is affiliated with Autonomous Driving Group, NAVER LABS, S. Korea giseop.kim@naverlabs.com

†This research was supported NRF (2020R1C1C1006620) and IITP (2022-0-00480) Korea.

I. Introduction

State estimation of robot poses and the surrounding landmark locations (well known as simultaneous localization and mapping (SLAM) [8]) is an essential task for a mobile robot to navigate an unknown environment. Particularly, for some harsh environments where visual information is easily degraded (e.g., subterranean [5] or nighttime [9]), the robust perception should be guaranteed for safe navigation. Recently, thermal-infrared cameras [10, 11, 12] have been employed to cope with such visually degraded environments where conventional gray or RGB cameras cannot provide rich information thus the existing visual SLAM algorithms