The Field Robotics Center

Seminar Series

Thursday, 8th December   **NSH 1507 10:00 – 11:00am**

Food will be served

Joe Bartels
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Multi-Modal Data for Perception in Smoke-Filled Underground Mines

Abstract: Mine rescue robots rely heavily on visual cameras and LIDAR, which succeed in clear conditions. However, the worst mine disasters are caused by roof falls, explosions, and fires, which generate thick dust and smoke that obscure traditional sensing and thwart robot perception.

This talk presents the failures of traditional sensing techniques in smoky conditions. Prior classical work investigated sonar, radar, and LIDAR. Sonar is unaffected by smoke but is only useful for safeguarding and hyperlocal navigation. Radar is coarse and lacks the resolution required for robot navigation. LIDAR and cameras are the sensors of choice, and prior perception methods include LIDAR-camera fusion for mapping, SLAM for exploratory modeling, and loop closure for navigating mine corridor networks. However, cameras and LIDAR—and hence their associated navigation methodologies—fail in heavy smoke.

This presentation introduces the merits of thermal and Episcan3D sensing in these environments. The Episcan3D is a new class of sensor that improves viewing and range sensing through light smoke. Rather than broad illumination, which creates whiteout in a smoky scene, the Episcan3D illuminates with only a single ray at a time, which reduces scatter. Yet, even the Episcan3D is obscured in heavy smoke. Thermal imaging is not obscured by smoke but succeeds best outdoors where large thermal gradients exist. Underground mines are isolated from large fluctuations in temperature, so thermal features are often too indistinct and sparse for traditional SLAM. This research specialized direct SLAM methods for operation on thermal imagery and evaluated their suitability for robot navigation in underground mines.

During this research, a multi-modal dataset was collected for future work toward robotic underground mine rescue. A rover carrying visual, thermal, inertial, and LIDAR sensors was deployed and driven through a smoke-filled mine. Applications of this dataset for future research include thermal SLAM, subterranean navigation, multi-modal mapping, sensor fusion, and victim identification.

Speaker Bio: Joe Bartels is a Ph.D. student in the Robotics Institute. His current research interests include sensing and perception for visually degraded environments. Prior to attending Carnegie Mellon University, Joe completed a B.S. and M.S. in Mechanical Engineering at the University of Nebraska-Lincoln.

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