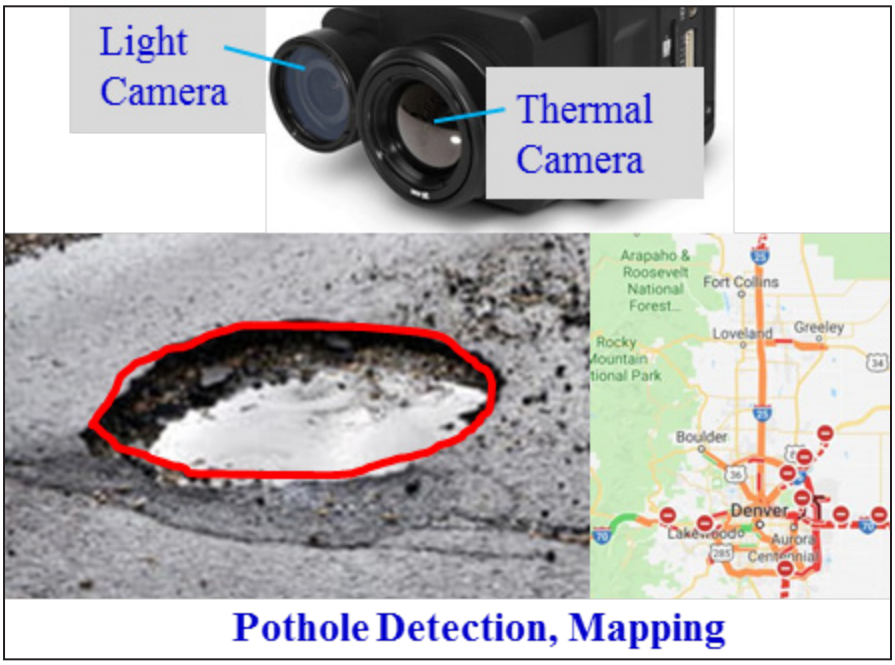
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 24-559 (project 620) | September 2024

Visible & Thermal Imaging and Deep Learning Based Approach for Automated Robust Detection of Potholes to Prioritize Highway Maintenance



the ISSUE

Potholes are a significant pavement distress compromising safety and causing costly damage to vehicles. Accurately and efficiently detecting potholes is essential for timely road maintenance and safety improvement.

the RESEARCH

This research developed an automated deep learning-based pothole detection and mapping tool using the fusion of visible and thermal images. Traditional methods using only visible images struggle with poor lighting and adverse weather, while thermal images alone lack the necessary detail. By fusing visible and thermal images, this project aimed to enhance detection accuracy across different conditions. This research created a database of labeled, geotagged images collected with a low-cost FLIR ONE thermal camera mounted on a vehicle. Three machine learning models were tested: Anisotropic Diffusion Fusion (ADF) + Mask R-CNN, RTFNet, and RTFNet with enhancement parameters (EPs). These models were trained on the database to detect potholes under various lighting conditions, including daytime, nighttime, and cloudy environments. The developed tool allows users to upload images for automatic pothole detection and mapping based on GPS coordinates, making it easier for transportation agencies to prioritize road repairs.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

Colorado State University
North Dakota State University
South Dakota State University
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

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Project Title

Visible and Thermal Imaging in a Deep Learning Approach to Robust Automated Pothole Detection and Highway Maintenance Prioritization

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the FINDINGS

The RTFNet machine learning model provided the highest detection accuracy, achieving F1 scores of 93.7% during the day and 90.9% at night. The inclusion of EPs further improved the performance under low-light conditions. The research demonstrated that fusing visible and thermal images significantly enhances pothole detection accuracy compared with using visible images alone. This approach is particularly useful in poor lighting and adverse weather, where relying only on visible images tends to fail. The project also developed an easy-to-use tool with a graphical user interface that allows highway maintenance teams to upload images and automatically detect potholes from images and map their locations for more efficient highway maintenance.

the IMPACT

This research will improve road safety and reduce maintenance costs by providing transportation agencies with a more accurate and efficient way to detect and repair potholes. The automated detection tool, which combines visible and thermal images, ensures reliable pothole identification under various conditions, particularly in regions with challenging weather. By streamlining pothole detection and mapping, agencies can allocate resources more effectively, prioritize repairs, and reduce the risks to motorists posed by deteriorating roads. This approach is scalable and cost-effective, making it accessible to agencies of various sizes.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1205

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.

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