# INSPIRE UTC Bridge Inspection Field Campaign Update, 2021

Pu Jiao, Liujun Johnny Li, Rafael Cardona, Genda Chen

## INTRODUCTION

Bridge inspection activities using robotic sensing system are surging in the recent years due to the increasing demand of infrastructure maintenance and development of commercial drones and open-source robotic platforms. On the other hand, the data acquired through bridge inspection is also booming, which stimulated the application of machine learning in infrastructure.

At INSPIRE UTC of Missouri University of Science and Technology, bridge inspection equipment's are being developed and tested for comprehensive data collection using multiple sensing technologies. This paper presents and evaluates the drone-carried sensors' abilities and applications after 3 bridge inspections in Missouri in 2021 and sketches the future inspection plans and database construction.

## METHODS

(1) Photogrammetry
Structure-from-Motion (SfM) is the process of reconstructing 3D structure from its projections into a series of images taken from different viewpoints. The resulting 3D models can be used for digital documentation and developing Augment Reality (AR) applications for measurement and inspection training.

(2) Passive IRT images
Passive IRT is applied to calculate the thermal overall heat transfer coefficient and to analyze moisture, cracking, thermal bridges and air infiltration, which can give us the information under the surface of the infrastructure.

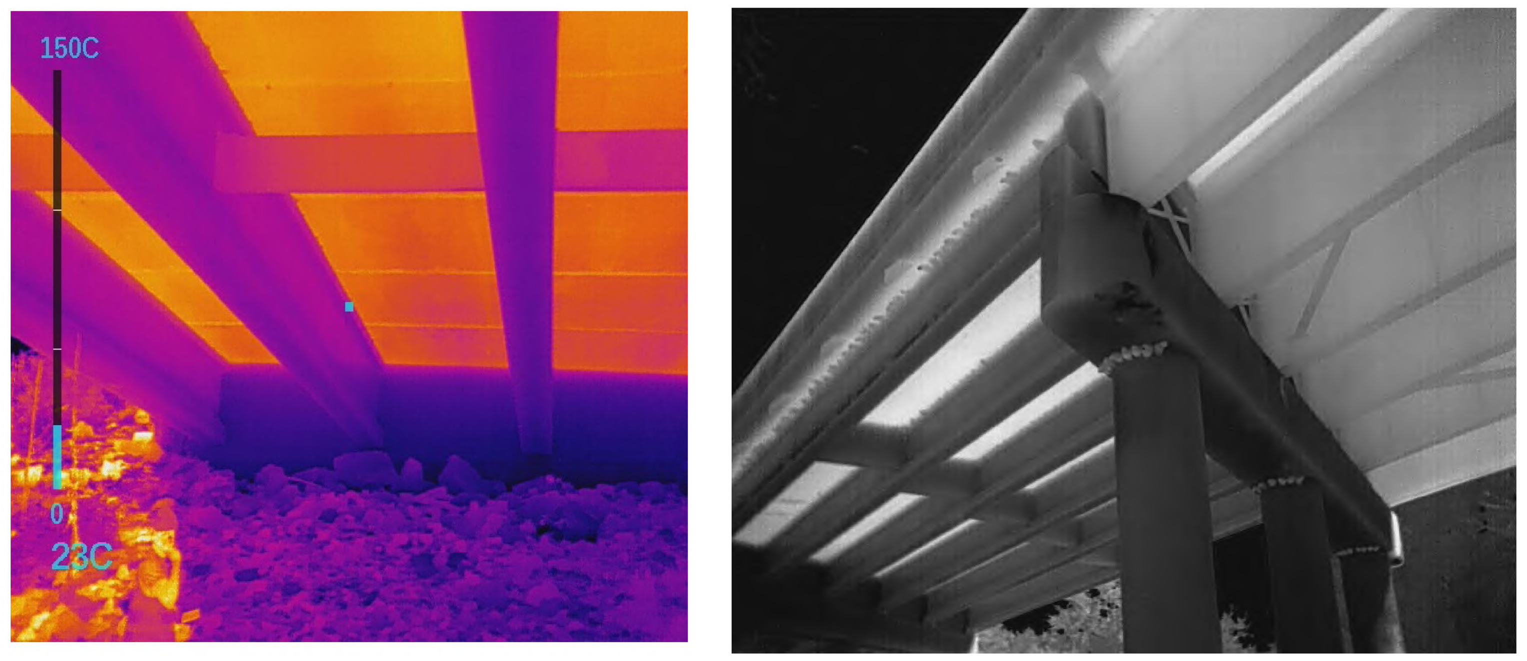
(3) Machine learning assisted crack detection
a pre-trained neural network based on 20000 concrete pictures with cracks and 20000 concrete pictures without crack is used to detect the captured pictures. The pre-trained neural model is based on ResNet50, which has the best performance compared with counterparts like GoogleNet and AlexNet.

## RESULTS

(1) 3D reconstruction

3D reconstruction results

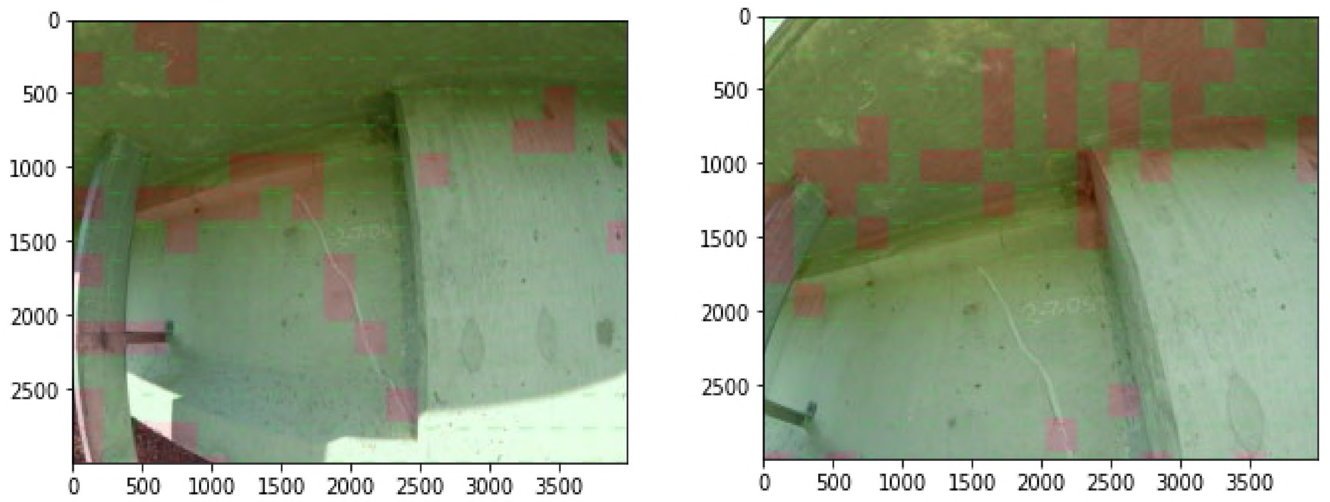
(2) Passive IRT images




IR image in colored mode and grey-scale mode

(3) Prediction by pre-trained machine learning model

Elios 2 during inspection




Elios 2 results processed by the pre-trained model

## DISCUSSIONS

Capturing the images for the bridge element 3D reconstruction using drones was made possible during the tests. However, the results also show the following problems (1) the shadows due to the sunlight and superstructure can affect the image quality, (2) manual control solves the GPS signal issue but increase the probability of image motion blurs.

Elios 2 can get into confined space for close-up inspection to take advantage of the ultra-wide-angle fisheye lens. However, the resulting images will have distortion compared with the other two drone's cameras' results. Lots of the existing machine learning model are based on images without significant torsion. Therefore, it is worth investigation to see how these new data will affect the performance of the existing models.

By using the pre-trained crack detection model with the data collected by the three drones, a deeper understanding of the acquired data as well as the existing concrete crack datasets is obtained. The model still has difficulty in dealing with homogenously illuminated regions.

Passive IRT imaging under the bridge can give information of the thickness or depth of the inspected targets, which can provide an extra layer for RGB images to assist member identification or semantic segmentation.

## FUTURE PLAN

1. Improve inspection plans based on data processing, annual meeting feedback.
2. Start to construct inspection database. Develop software to assist the tagging work. Include more damage classes like crack, delamination, corrosion, spalling and others.
3. Data fusion with different sensors to gain a comprehensive evaluation of the bridge condition.
4. Work with state DOTs on data masking to share the inspection data with general public.

## ACKNOWLEDGEMENTS

Financial support for this study was provided in part by Missouri Department of Transportation TR202004 and FHWA pooled fund TPF-5(395), S064101S under the auspices of the Center for Transportation Infrastructure and Safety at Missouri S&T.