

Computer Vision-Based Structural Deformation Monitoring System on Android Smartphones: Design and Implementation

Xiang DONG*, Maokai LAI*, Hui LIANG**, ***, Peng WU*, Chaoxia WANG****, Ting PENG*

* Chang'an University, Xi'an 710064

** Shaanxi Huashan Road and Bridge Group Co., LTD. Xi'an 710016

*** Shaanxi Zhengcheng Road and Bridge Engineering Research Institute Co., LTD. Xi'an 712000

**** Xi'an University of Posts and Telecommunications, Xi'an 710061

1290740787@qq.com, 3412303785@qq.com, 5936001270@qq.com, 1169886830@qq.com, 2102332664@qq.com, t.peng@ieee.org

Abstract—Computer vision displacement monitoring techniques offer a promising alternative to traditional displacement sensors, but most current approaches or systems use high-cost cameras and require limited measurement sites. To facilitate widespread implementation in real-world engineering, simpler systems or approaches are needed. This paper introduces a computer vision-based structural deformation monitoring system, written and developed using OpenCV and Kotlin. The system uses an Android smartphone camera and telescope as the acquisition device and adopts template matching technology based on digital image correlation to realize target displacement monitoring. A real-time display of the offset curve is realized with MPAndroidChart, and socket TCP communication is used to transmit the monitoring data. The detailed operation process of the system is shown as an example of dynamic detection. The test results show that the system runs smoothly, is easy to operate, and has the following advantages: 1) Low cost of hardware composition and simple construction process; 2) High monitoring accuracy (accurate to 0.01 mm); 3) High monitoring frequency (up to 10 frames per second in dynamic detection mode); 4) Visualization of monitoring data, with the monitoring structural offset presented in real time as a curve for easy user comprehension. Overall, this system can provide technical and auxiliary decision support for structural deformation monitoring.

Keyword—Computer Vision, Kotlin, OpenCV, Structural Deformation Monitoring, Socket TCP



Xiang DONG is a postgraduate student at the Highway School of Chang'an University. She received her B.S. degree in Transportation Engineering from the City College of Southwest University of Science and Technology in 2022. Her current research interests include intelligent detection technology for infrastructure and engineering data analysis.



Maokai LAI is an undergraduate student at Chang'an Dublin International College of Transportation at Chang'an University. Pursuing a dual undergraduate degree in Transportation Urban Planning and Environmental Policy. His current research interests are in intelligent transportation.



Hui LIANG is working as a researcher with Shaanxi Zhengcheng Road and Bridge Engineering Research Institute Co., Ltd., and Shaanxi Huashan Road & Bridge Group Ltd. She received a master's degree in Materials Science and Engineering from Chang'an University in 2013. Her current research interest is applied research in highway municipal engineering.



Peng WU is a postgraduate student at the Highway School of Chang'an University. He received his B.S. degree in Civil Engineering from Chongqing Jiaotong University in 2022. His current research interests include intelligent detection technology for infrastructure and engineering data analysis.



Chaoxia WANG is a postgraduate student at the Xi'an University of Posts and Telecommunications. She received the bachelor's degree in Software Engineering in Shandong Technology and Business University in 2022. The current research interest is deep learning, and the surface defect detection with industrial products.



Ting PENG is an Associate Professor in the Highway School of Chang'an University. He received his B.S. degree in Highway and Urban Street Engineering from Xi'an Highway University in 1999, his M.S. degree in Road and Railway Engineering from Chang'an University in 2004, and his Ph.D. degree in Computer Science from Xi'an Jiaotong University in 2010. His research interests include infrastructure monitoring, big data mining for engineering, highway assets management systems, and artificial intelligence applications.