UNIVERSITI TEKNOLOGI MARA

POTHOLE DETECTION USING MULTISPECTRAL SENSOR AND UNMANNED AERIAL VEHICLE IMAGERY

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ABSTRACT

Today, it is truly stimulating for the road management department to rapidly obtain large-scale technical insights into road pavement conditions, particularly with the rapid expansion of road networks, especially highways. In earlier times, conventional methods such as field investigations and manual measurements were utilized to collect data and assess pavement distresses. The aim of this study is to evaluate the effects of multispectral sensors on pothole detection using very high-resolution images captured by Unmanned Aerial Vehicles (UAVs) based on the structure-from-motion photogrammetry approach. The study has three objectives: to evaluate the accuracy of 3D pothole estimations from UAV images compared to actual pothole data, to investigate the impact of multispectral band combinations on pothole edge detection, and to assess different algorithms for pothole area extraction using multispectral and visible images. Aerial photos were acquired using the Mavic 2 Pro quadcopter UAV, which conducted flight missions at varying altitudes for RGB imagery data. Additionally, the DJI Phantom 4, equipped with a multispectral sensor (Parrot Sequoia), collected multispectral imagery data during flights at a 10-meter altitude. The flight missions were conducted in two study areas with asphalt surfaces affected by potholes, where measurements and assessments were carried out to gather distress data. Pothole dimension data were obtained from manual on-site measurements and compared with automated measurements using 3D models processed in Agisoft Modeller software, revealing higher accuracy at a low altitude of 2 meters. The optimal band combination for pothole detection involved utilizing two or more bands, including the green and red bands, resulting in the highest accuracy. Furthermore, this study demonstrates that Support Vector Machine (SVM) consistently outperformed the Maximum Likelihood Classifier (MLC) in pothole classification, achieving an overall accuracy of 95.77% and 99.1% compared to MLC. The findings of this study can contribute to improve guidelines for local authorities, such as Jabatan Kerja Raya (JKR), and professionals in performing systematic pothole maintenance, enhancing existing methods such as the IKRAM Road Scanner (IRS), a specialized vehicle equipped with a wide array of survey products for scanning pavement distress.

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INTRODUCTION

1.1 Research Background

Roads are one of most vital infrastructures in Malaysia, where the network built play a critical part in supporting the expansion of an economy and human civilization. The quality of roads defines the lifetime of one road segments. Therefore, maintaining roads in a good condition are very important. Distresses always occur on the pavement during road usage, usually due to combination of corrosion and effect of aging of the road surface. Cracks and potholes are the two mutual classes of road distresses and have significant impacts on the excellence running of vehicles (Pouteau et al., 2022).

Despite the problems of road surface damages, inspection on road condition is the main work of road department should carry out before road maintenance and rehabilitation. Today, it is really a stimulating work for the road management department for quickly obtain the large-scale technical condition of road pavement due to the rapid growth of roads network, especially the highway. Earlier days, conventional method was used such as field investigations and manual measurements in collecting data and assess the pavement distresses. However, due to the advanced computer and remote sensing technologies, many forms of data have been introduced in automated detection of damages pavement without harming the road pavements. For example, from the previous research, digital images and videos of single or RGB channel captured, using mobile vehicles, are the most frequently used data type in detecting the pavement damages (Ren & Zhao, 2022).

The vehicle mounted with sophisticated and heavy remote sensing devices which is the common platform being used to collect data for roadway monitoring by most of road departments (Boccardo et al., 2015). Nevertheless, mobile vehicles may have facing potential risks of normal traffic order and safety of another user. Moreover, the camera attached on the vehicles can only cover small area of the road during data collection. Therefore, it may cost in term of time duration and capital lost due to the method is incapable to collect data for full pavement of different lanes at once. In last few years, UAVs or drones are commonly used in applications where the operating site cannot be access by land vehicles or applications that require in-flight or airborne view