

Automated detection of tower insulator and transmission cable damage using deep learning with quadcopter integration

Samaraweera K.M.S.K., Udayanga S.G.N., Chamudika A.K.S., Canistus G.A.* , and Mauran M.

Department of Engineering Technology, Faculty of Technology, University of Jaffna, Sri Lanka

*canistus@tech.jfn.ac.lk

The paper proposes a new automated method of tower insulator damage and transmission cable fault detection by combining deep learning and aerial surveys conducted by quadcopters. In Sri Lanka, the traditional inspection method is a manual visual inspection, in which the workers have to climb the high-voltage towers, which puts them at significant risk of safety and operational inefficiency. The suggested system uses the deep learning model YOLOv12 to process high-resolution video recorded by a First-Person View (FPV) camera on a quadcopter. This method identifies the defects in insulators in real-time, with high precision, insulator broken, missing caps, pollution flashover, and other structural damages. The AMG8833 thermal module connects to the ESP 32 and incorporates thermal graphical representation via Wi-Fi into the system, enabling the detection of thermal anomalies that can be used to diagnose overheating or electrical faults, and thus detect transmission cable breaks. Even though the present prototype uses the low-cost AMG8833 module, subsequent models will use more precise thermal cameras with a higher resolution. Onboard processing and remote GPU based analysis using a laptop with an RTX 3060 GPU ensure efficient data processing. Manual control of the quadcopter covers the maximum number of transmission lines and towers and saves energy. The main aim of the study is to automate the inspection process, decrease the cost of operations and enhance safety by minimising human participation in risky activities. The combination of deep learning and UAV technologies makes the system more efficient and scalable than traditional methods of power grid maintenance. Preliminary findings prove that the system can significantly reduce the time of inspection and increase its accuracy and safety. This automated inspection platform is a radical solution to power grid maintenance, providing a dependable, economical way to identify faults in transmission cables and tower insulators. The system will help to increase the safety, reliability, and sustainability of the power infrastructure in Sri Lanka by reducing manual labour and increasing the accuracy of defect detection.

Keywords: *Deep learning, Thermal graphical representation, Tower insulators, Transmission cables, Quadcopter integration*