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Autonomous flight method for a drone to inspect a power transmission facilities

Munsu Jeon[1], Siheon Jeong[1], Joon-hyeck Moon[1], and Ki-Yong Oh[2,#]

1 Department of Mechanical Convergence Engineering, Hanyang University, 222, Wangsimni-ro, Seongdong-gu, Seoul, Republic of Korea
2 School of Mechanical Engineering, Hanyang University, 222, Wangsimni-ro, Seongdong-gu, Seoul, Republic of Korea
Corresponding Author / Email: kiyongoh@hanyang.ac.kr, TEL: +82-02-2220-3116, FAX: +02-2220-3129

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This study proposes an autonomous flight method for a drone to inspect power transmission lines and auxiliary facilities by deploying a novel deep neural network and a 3D LiDAR-optical camera sensor fusion method to effectively cognize surrounding environment. The proposed method aims to overcome limitations of a current inspection method with autopilot based the drone. A current autonomous flight method for a smart drone inspection system requires the coordinates of transmission towers. Moreover, surrounding environment in an autonomous flight path should be cleaned, suggesting that a path should be checked in advance to secure safe and reliable autonomous flight and inspection. The proposed method mainly comprises two tracking phases for the power transmission tower and lines. First, the drone detects the surrounding power transmission towers through the rotational bounding box with multi-level feature pyramid transformer [1] after takeoff. One power transmission tower of interest is designated, the drone automatically generates a path and then follow the path generated, which denotes a straight path between the drone and the designated power transmission tower. In addition, the distance between the drone and the power transmission tower is calculated to secure a safe distance by using 3D point cloud data and inertial measurement unit [2] in real time. The several unsupervised learning techniques include Random sample consensus (RANSAC) [3] with Kalman filter and Euclidean distance clustering (EDC) [4] are addressed to locate the power transmission tower in real time using main characteristics of the power transmission tower. The, this phase changes to the second phase through sensor fusion methods combining information from an optical camera and a 3D LiDAR sensor when the drone closely approaches to the power transmission tower. In the second phase, several unsupervised learning-based environmental recognition methods, including RANSAC [3] and EDC [4], are deployed to extract a point cloud data of transmission lines. Then, a catenary curve representing a shape of a power transmission line is estimated with point cloud data of a power transmission line, generating a trajectory of the power transmission line for autonomous flight. Based on the generated trajectory, the drone follows the power transmission lines in sequence to inspect the top line, the middle line, and the bottom line. GPU embedded microcomputer enables all procedures of autonomous flight including trajectory planning and tracking by the position control feedback system [5]. Finally, the drone returns to a home point, terminating the inspection. The effectiveness of the proposed method is validated by a hardware in the loop system (HLIS). Moreover, the robustness of the proposed method is secured through intensive field tests. HILS and field test results reveal that the proposed method successfully achieves the transmission tower tracking without coordinates of transmission tower and the transmission tracking for smart and unmanned inspection. Furthermore, safe and reliable flights would be secured to inspect power transmission facilities with the proposed method.

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