A novel design of inspection robot for high-voltage power lines

A. Mostashfi and A. Fakhari
Department of Mechanical Engineering, Isfahan University of Technology, Isfahan, Iran, and

Mohammad Ali Badri
Research Institute for Subsea Science and Technology, Isfahan University of Technology, Isfahan, Iran

Abstract

Purpose – In this article, a detailed design of a novel power line inspection robot is studied. This robot can be used to move on ground wires for special purposes such as inspection and fault detection of electric power lines. The paper aims to discuss these issues.

Design/methodology/approach – Designed active and passive mechanisms in the proposed robot enable it to move over various obstacles on ground wires, such as clamps, warning balls and mast tips. Indeed, this robot is the first designed robot with the capability of moving over all ground wire obstacles. The active mechanisms contain seven rubber-coated rollers (i.e. four vertical rollers and three horizontal rollers) as well as three mechanisms in order to make horizontal rollers move vertically. The passive mechanisms also include a set of spring-dampers installed in each joint of robot arms.

Findings – The simulation results in the ADAMS software revealed a desirable stability of performance when moving on the ground wires with a maximum slope of 30-degree. Also, the robot showed a suitable performance when passing over the warning balls (with a maximum diameter of 700 mm), rectangular mast tips (170 × 170 mm) and mast tips with a 30-degree twist in the horizontal plane.

Practical implications – The feasibility of these maneuvers is proved with a prototype implementation and successful test results. This robot is approximately 60 kg weight and can move in ground wires with maximum speed of 20 m/min.

Originality/value – The proposed robot is able to move on ground cable and pass over different kinds of obstacles like warning balls and mast tips (straight and angular) with maximum speed of 20 m/min.

Keywords Robots, Inspection, Autonomous, Climbing

Paper type Research paper

I. Introduction

Nowadays, high-voltage transmission lines are one of the vital elements of urban life. These lines transmit the electricity power from the generators to the cities and industrial centers. Consequently, any damage and disruption to these lines can cause serious problems in transportation systems, security systems, hospitals, and industries. Therefore, inspection and maintenance of high-voltage transmission lines have considerable importance to prevent further detriment in the aforementioned areas (Wang Peng *et al.*, 2010).

On the other hand, inspection of high-voltage transmission lines would be very dangerous if performed by human forces. One of the preliminary methods for inspection of transmission lines is using helicopters to take images of the lines (Ishino and Tsutsumi, 2004; Golightly and Jones, 2005). These methods are so expensive and also dangerous because of flying the helicopter around the transmission lines. Hence, the application of robotic devices for the purposes of transmission lines inspection has been seriously considered. The first prototype of these kinds of robots was proposed for inspection of telephone lines by Aoshima *et al.* (1989). As an initial prototype, it suffered several limitations such as complexity of control system and low speed of movement. Sawada *et al.* (1991) designed a robot in order to inspect the optical fiber lines. The latter robots were capable of moving on the lines with 30-degree slope and passing the mast tips, however, they still lacked the speed of motion and stability. Higuchi *et al.* (1991) suggested a more advanced robot for inspection of power lines. They tried to solve the stability problem while passing over the obstacles, but it still had problems when passing over the clamps and other complicated obstacles. Tsujimura and Morimitsu (1997) designed a wired-suspended mobile robot for inspection of telecommunication cables. Their robot was able to pass different kinds of obstacles on the wires in a snake like motion using linkage mechanism. Although their robot was ideal because of its constant speed, it was not able to pass the mast tips change the line direction. One of the most advanced power transmission lines inspection robots is LineScout developed by Montambault and Pouliot (2007). This robot is able to pass the different kinds of obstacles on the phase lines in a high speed motion. However, in spite of high performance of the robot in field tests for moving on straight transmission lines, it still requires more improvements in order to pass the mast tips change of line direction. A variety of other line inspection robots with different purposes are introduced and described in Toussaint *et al.* (2009) for interested readers.

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