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Optimum design of a walking tractor handlebar through many-objective optimisation

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Abstract. In this work, a comparative study of multi-objective meta-heuristics (MOMHs) for optimum design of a walking tractor handlebar is conducted in order to reduce the structural mass and increase structural static and dynamic stiffness. The design problem has objective functions as maximising structural natural frequencies, minimising structural mass, bending deflection and torsional deflection with stress constraints. The problem is classified as a many-objective optimisation since there are more than three objectives. Design variables are structural shape and size. Several well established multi-objective optimisers are employed to solve the proposed many-objective optimisation problems of the walking tractor handlebar. The results are compared whereas optimum design solutions of the walking tractor handlebar are illustrated.

Keywords: many-objective optimisation; natural frequency; walking tractor handlebar; structural stiffness; vibration suppression

1. Introduction

Nowadays, agricultural machinery has increasingly become a necessary tool in various farming countries because it can respond to the problem of human comfort, labour force shortage and working hours. A walking tractor is one of the most used terrain vehicles in various farming countries including Thailand, the country in which the majority of people are related to agriculture in one way or another. The handlebar is the main part of the walking tractor used to control the walking tractor. Under working conditions, the structure is subjected to several mechanical phenomena such as; bending stress failure, torsion stress failure, and vibration issues (Fabbri *et al.* 2017, Kanyakam and Bureerat 2007). In addition, some of the mechanical phenomena such as vibration transmissibility can cause human injury such as complex vascular, neurological and musculoskeletal disorder, which are collectively named as hand-arm vibration syndrome (Bovenzi 1998). To our best knowledge, the design of walking tractor is mostly focused on structural strength while the ergonomic effect is rarely considered in the design. Therefore, design optimisation for optimum ergonomic effect and structural mass simultaneously with maximum structural strength of the handlebar is needed.

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