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OPTIMIZATION OF WHEG ROBOT RUNNING WITH SIMULATION OF NEURO-FUZZY CONTROL

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Abstract

This paper presents laboratory simulator for wheel – legged (Wheg) robot running and application for collecting measurement data. Data is used as a basis for modelling and optimization of energy consumption of running Wheg. The laboratory setup includes instrumented measurement treadmill (IMT) and Wheg drive. The laboratory experimental setup also includes the sensors, drives and software application. Intelligent modelling and optimization of energy usage during Wheg's running is based on a combination of neural networks and genetic algorithms. Neural network has established a correlation between the parameters of running. Using genetic algorithm optimal parameters for running are found. Simulation of neuro-fuzzy control system for minimization of energy usage during running was developed as a function of the angle and Wheg running speed.

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Key Words: Instrumented Treadmill, Wheg, Neural Network, Genetic Algorithm, Neuro-Fuzzy Control

1. INTRODUCTION

The legs of insects, animals and humans allow them to move on flat and uneven terrain. Also, these creatures can walk on different types of substrates such as land grass, rocks, concrete, etc. Gait pattern in these creatures relatively easily adapts to the current state of the terrain. The current development state of the robots which mimics the gait of these creatures is not at that level and cannot be easily adapted to different types of terrains. Usually, the robots are created for specific types of terrain. No robot can still adapt to any type of terrain. Legged robots that have the possibility of moving over rough terrain are usually with complex structure. They have a large number of motors, complex control algorithms and they are inefficient. One of the most advanced legged robots today Atlas [1] is still not at that level that can autonomously navigate throw unknown terrain. There are many robot creations that are inspired by animals. One of well-known robots of this type is BigDog [2], as well as the fastest four-legged robot Cheetah [3]. Disadvantage of these robots is very poor energy efficiency due to the large number of actuators and rigid construction. There are a large number of robots in which the passive compliant elements in the various forms are used for robot legs like RHex [4]. This type of robot has a smaller number of actuators usually 6 as RHex or 4 like quad robots [5]. Large number of papers deals with the possibilities of increasing energy efficiency by usage of passive compliant legs [6]. The use of different configurations of compliant passive elements for legs affects the efficiency of robots (Fig.1 a) Also, change in flexibility of legs during robot's moving, affects the efficiency of robot and possibility to move over different terrain [7,8]. Authors in [9] introduced the concept of double Wheg – dWheg (Fig. 1b). Change of the angle α on dWheg affects the flexibility of Wheg spokes, which enables and optimize move over different terrain. The authors of this study did not analyse the energy consumption at different speeds and angle α. The analysis can be carried out in three ways. The first method directly measures parameters on the robot