Bionic Hexapod Robot and Study of Improving Walking Efficiency

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Hexapod robots have been utilized in numerous applications, such as post-disaster rescue and inspection of unknown territories. The kinematic analysis of the robot calculates the relative position of the leg tips when the robot is walking through transformation matrices. The forward and inverse kinematic model of one leg of the robot is programmed in MATLAB. Furthermore, a new mathematical model is introduced to simplify the calculation of kinematic analysis by using trigonometry instead of linear algebra. In addition, the design of the hexapod robot is based on the bionic model inspired from insects. The mechanical structure is modeled after the body structure of insects, while the gait program is modeled after the gait patterns utilized by insects. The body part of the robot is designed as an elongated hexagon to ensure walking efficiency and stability. However, the hexapod robot displays lower walking efficiency when its legs sink into the ground since the robot dissipates time and energy to pull out legs. An easy yet effective solution is to increase the contact area of the robot on the ground since larger contact area reduces the pressure exerted by the robot and the depth of sinking into the ground. An experiment-based study initiates with the hypothesis that the walking efficiency of the hexapod robot increases as the contact area increases; however, continuing to increase the area eventually fails to improve efficiency significantly or even provides negative effect. The hypothesis is proved by two sets of experiments: one is conducted on the smooth surface, while the other is conducted on sand slopes of different degrees of inclination. The results prove the existence of an optimal contact area that is most effective in improving walking efficiency.