仿生四足機器人在障礙路面的步伐規劃與實驗

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摘要

本文主要目的在規劃四足步行機器人的行走步伐並實際進行控制，以靜態穩定條件下的基本步伐為基礎，透過步伐變換的設計和感測器的回授判斷，使機器人能在障礙路面上快速且穩定的行走。

本研究提出四足機器人步伐軌跡規劃法則及建立其電腦輔助系統，用以建構直線行走的最大跨步長度的控制軌跡，及由直線變成任意旋轉角度旋轉步伐的步伐轉換複合步態。藉此可因應組合曲線路線與障礙路面的控制軌跡，使機器人能夠進行一般的漫遊與跨障的運動。此外，並研發完成一套結合 BASIC Stamp 2 和 89C51 的單晶片控制系統，能使機器人脫離一般電腦系統而獨立運作，進行步進馬達的運動控制，再從感測器獲得未知地形資訊，使其能配合路面障礙自動調整步態，穩定而順利地到達目的地。

經實驗驗證，本研究之四足機器人，在直行時能以最大直行步伐前進，而新的步伐轉換設計減少了運動時贅步發生的情形，使機器人能在保持移動的狀態下，更快一步的變換成其它步伐。並能在非平坦路面保持穩定的行走，且能夠自行跨越或避開道路上的障礙，證明本研究的步伐規劃法則與輔助系統在四足機器人的步伐規劃與控制系統上之可行與效益。

關鍵詞：四足機器人、步伐軌跡規劃法、步伐轉換、BASIC Stamp 2、89C51 單晶片、感測器。

Gait Design and Experiment of a Bionic Quadruped Robot Walking on Irregular Terrain

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ABSTRACT

The purpose of the research is to design the walking gait for a quadruped robot and control it actually, based on standard gait and static stability. Through the gait transition method and the judgment of sensor feedback, the robot can walk fast and steadily on irregular terrain.

In this research, the computer aided gait planning system of quadruped robot was proposed to construct the longest trajectory of crawl gait in all directions, and to design the transition gaits from crawl gait to spin gait which can turn to any rotation angles. It also can generate the composition gait which is used for the quadruped robot on the curve route or irregular terrain. By this way, the robot can walk everywhere and avoid the obstacles. In addition, a net based single chips composition control system with BASIC Stamp 2 and 89C51 was developed. The system can control the robot stand along without the support of general personal computer system, and can control the stepmotors by using the command data derived based on kinematics and motor theory and retrieve the feedback data of the unknown terrain information from the sensor. It also provides the possibility for the robot transforming the gait according to the terrain information automatically. Then, robot can arrive to the goal steadily and smoothly.

By the experiments, the quadruped robot (NC-F4) in this research has been demonstrated to walk with the longest stroke line of crawl gait. The happen chance of deadlock was reduced while walking with the proposed new gait transition method. The gait of robot can be transited into other gaits without slowing down, and can keep steady walking on non-smooth terrain, cross over or avoid the obstacles on the road. Under the previous verification experiment, the feasibility of gait transition method and the benefit of computer aided control system to quadruped robot has been proved.

Keyword: quadruped robot, gait transition, BASIC Stamp 2, 89C51, sensor