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Research Article

Wheel-legged Integrated Hexapod Robot

Kaicheng Yu

Shenzhen Senior High school, Shenzhen, China

Abstract: This research is applied mainly for routine inspection, rescue missions in multi-terrains environment. The main process of developing this hexapod based wheel-legged robot includes mechanism structure design, electronic devices configuration, gaits' control adjustment and pathing route simulation. With the use of transformable wheel-legs, the robot can run flexibly in flat under the wheeled mode, and through the gear and mechanism system, it would shift to legged mode to show enough capability for overring the unstructured obstacles. As the expectation, this robot would have bright prospects for variable terrains application and substitute current rivals by its higher efficiency and adaptability.

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****Corresponding author:*** Kaicheng Yu, wangyifei@xyzrgroup.com

1 Introduction

Robots with locomotion of multi-legged, wheeled and many other kinds are widely used to substitute people in some special work. They are expected to face with adverse environments that cannot directly enter by human because of the space limitation or potential threat to life security, to detect variable sensate information in high efficiency, for supporting further strategic decisions making. As these properties, there are bright prospects for their application, especially including the rescue missions and certain core areas safeguard situations. For chasing the potential benefits, amount of research teams and companies are dropping in this field's study, which objectively bring giant improvements on the robot relative technologies. Following the times, most universities currently have their own labs focus on this direction, and the related company, Boston Dynamic, is looked to further increase by public because of their high-performance bionic robots.

The locomotion type normally is single in most robots, which is a significant drawback for complex terrains application. Generally, wheeled robot can be disposed quickly in flat, and traditional legged robot is easy to handle unstructured environments, but both two lose the advantages that their counterparts have. To solve this problem, some high-tech companies, like Boston Dynamic, tend to design the leg and adjust the control system of robot to simulate skeletal structure and the complicate gaits of higher animals to approach some advanced achievements. There is no doubt that it is a brilliant solution, however, for this kind of design would always have large body which cannot be operated in tight space, besides, the complex system increases the difficulty of maintenance and the overall cost.

Wheel-legged robot, combined the advantages of both wheeled and legged, may provide a new solution to overcome those mentioned problems. As one of latest research subfields of conventional legged locomotion type, it seems like a way to obtain a perfect balance between small body and multi-terrains adaptability. The core design part is the transformable wheel-leg structure; robot with the locomotion by wheel-leg which could transfer the configurations of its 'feet' to fit special cases, which can combine wheeled and legged robots' advantages but avoid their shortcomings.

By using this wheel-legged plan, it would dramatically decreases the difficult of overall design, but only focus on the wheel-leg combination, besides, its advantages and the no need of huge body, which could easily to cross through unstructured terrains without lose flexibility in limited space. Apart from these, this design should also have a relative low price

and maintenance cost.

2 Case validation

2.1 Example.1

The robot is placed in a test field in wheeled mode. First, turn on the power and the robot control system. The control system would scan the surrounding environment through the sensor at once, then, the stepper motor starts to work by the order based on this collected information. On a flat surface, the robot's forward gestures will be adjusted by the control system to complete the straightforward task. For those unstructured terrains (not an obstacle), once being detected, the control system will issue a foot deformation command to start the auxiliary stepper motor associated with the deformation and decelerate the main stepper motor at the same time. After the wheel-leg structured has been transformed completely, the auxiliary stepper motors will be stalled and speed up the main motor to march. Finally, the robot successfully converts the mode from wheeled to legged. (NOTE: the default gesture now is tripod gait).

2.2 Example 2

Test of the robot's ability to over obstacles. Based on the ultimate obstacle height which has already been obtained in software simulation, the following judgment system and operation control are designed.

(1) Once the sensor detects the front obstacle is lower than the ultimate obstacle height in theory (90% of the ultimate obstacle height in computer simulation), a serious of control signal will issue the obstacle-obeying command. In general, tripod gait will shift to the waving gait and decelerate the forward speed which increase the pulling force. While the obstacle crossing operation is completed, and no more obstacle can be determined by sensors, another gesture transition feedback will command the robot return to the tripod gait with the velocity recovery.

(2) If the front obstacle height is detected as unachievable by comparing the ultimate obstacle height in theory, a turning round command will be issued. The robot will perform a direction steering action immediately, change the head direction with certain degrees interval for times, until an available route is found by the sensor system. At the same time, the main motors speed would slow down to support the whole control procedure.

3 Conclusion

According to the advantages in theories, this wheel-legged robot is capable to substitute those current used rivals in typical application conditions, where restrain human by space limitation and threat to life safe. So that, it is available to detect variable sensate information at much higher efficiency than single-function wheeled or hexapod robots, in rescue missions of wasteland, core areas safeguard or military intelligence collections. Normally, this wheel-legged robot uses the wheel mode for flexible disposition in surface, thence the wheel transfer to leg mode, if necessary, for overring other unstructured terrains; by absorbing the positive properties from counterparts, wheel-legged robot can be much more compatible.

In conclusion, this wheel-legged invention is a production based on a hexapod robot to compromise the speed, the obstacle crossing function and the system steady as pervious analyses. Through the computer and manipulator’s control, it could meet the design purposes to handle dangerous, tactical jobs by calling variable sensors and equipment.