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STAIR CLIMBING ROBOT

Engineering

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ABSTRACT

In today's life, technology concerned with robots plays an important role in many fields because they are used to operate in hazardous and urban environments, for security, in traffic system, rescue mission as well as military operations. Some of the e robots are designed to operate only on natural terrains, but it can also use for rough terrains and artificial environments including stairways. This article represents the mechanism of how will robot climb the stairs carrying load. Its mechanical design is suitable with front wheel and back wheel driven by DC motor for climbing stairs .Although many robots had been introduced earlier have some problems like need of special device or software to control the robot etc. This article suggests an advance method for robotics control using the mechanical links. Until recent years, the stair climbing robots are designed with vast hardware and robots are equipped with chain roller to climb stairs or to move on a flat surface. The mechanical design of the this robot contains the fixed and flexible links of wheel legs instead of chain roller moves relative to each other to generate high friction with stairs.

INTRODUCTION

Adjustable stair climbing robot is one of the most attractive performances of robot in legged and wheeled. Developments have been made on various kinds of stair climbers, considering how to make its climbing ability higher and its mechanical complexity reasonable and practical. The research includes realizing a large step negotiating. Reducing body weight and energy consumption is also the important matter of developing. We introduce some solutions to realize stair climbing machines that we developed. Each of them has good performance as in a category of their kind, e.g. various numbers of wheeled shapes. Then, we discuss a development of adjustable high-grip mover, which we think one of the best solutions as the stair climber .A mechanism is a combination of rigid or restraining bodies so shaped and connected that they move upon each other with definite relative motion. A machine is a collection of mechanisms which transmits force from the source of power to the load to be overcome, and thus perform useful mechanical work. Robotics is the area of automation which integrates the technology in variegated fields like mechanisms, sensors & electronic control systems, artificial intelligence and embedded systems.

2. RELATED WORK

Stair climbing has been carried out with robots using different types of mechanisms. One can roughly distinguish wheeled, legged, and tracked robots.

2.1. Wheeled robots

Wheeled robots usually have to resort to mechanic extensions to overcome stairs. One application of such a technique is inpatient rehabilitation, where stair climbing could greatly enhance mobility, and thus quality of life, of people confined to wheelchairs. Lawn and Shiatsu present a stair-climbing wheelchair using two (forward and rear) articulated wheel clusters attached to movable appendages. The robot is equipped with step-contact sensors, but relies on user steering and is thus only semi-autonomous.

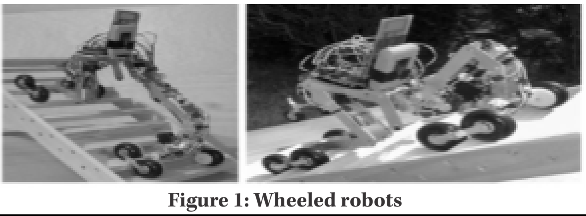

Figure 1: Wheeled robots

2.2 Legged robots

Figliolini and Ceccarelli present the architecture of the bipedal robot EP-WAR2, that uses electro pneumatic actuators and suction cups for locomotion. In order to climb stairs, the robot relies on an open-loop control algorithm implemented as a finite-state machine. The main limitation of the approach is that operating in a different staircase necessitates manual recalibration.

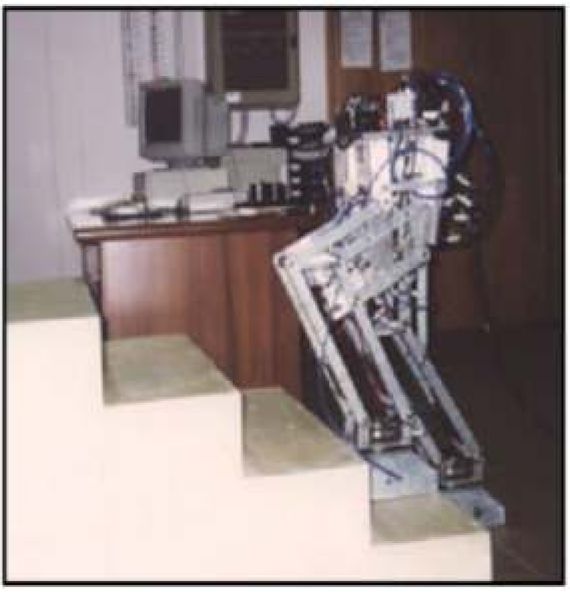

Figure 2: Legged robots

2.3 tracked robots

Tracked robots have a larger ground contact surface than wheeled vehicles and are more stable than bipeds due to their low center of gravity. Liu et al.[3] derived the fundamental dynamics of the stair-climbing process for a tracked robotic element, analyzing the different phases of riser climbing, nose crossing, nose line climbing and the effects of grouser bars or cleats. The analysis is limited to 2D, and slippage, shocks, and intermittent loss of track-surface contact, phenomena that are commonly encountered during stair climbing, are neglected.

Figure 3: Tracked robots

3. STAIR CLIMBING ROBOT PRINCIPAL AND COMPONENTS

3.1 Stairs

Characteristic length CN and slope of the stair are defined as $CN=\sqrt{W^2+H^2}$ and $\tan\alpha= (H/B)$, respectively, where W and H are width and height of each step. Empirically measured nominal value of W and H of domestic stairs are 25 cm and 18 cm, accordingly, and the standard deviations of W and H are 2cm and 1.5 cm respectively.

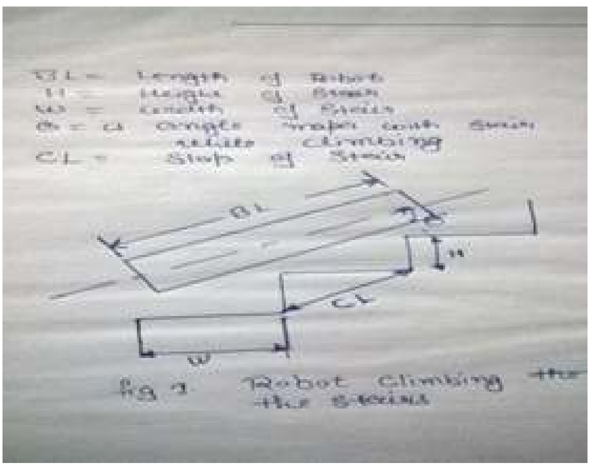

Figure 4: Trajectory of stair

3.2 Individual leg motion

Each leg is required to be capable of two degrees-of-freedom (DOF) planar motion in the sagittal plane. The subscripts FR, FL, HR, and HL denote front right, front left, hind (back) right, and hind (back) left legs, respectively. For simplicity, the foot position of each leg will be represented in

the polar coordinate (l,θ) with its origin located at the hip joint of each leg Hi, i=FR,FL,HR,HL.It should also be noted that the 2 DOF articulated leg is also compatible with the following development, since its joint angles (θ_1, θ_2) can be transformed into the polar coordinates using straight-forward trigonometric operations.

3.3 Leg arrangement

Front/back joints of right and left legs coincide at the same point from a side view. Body length AB is defined as the distance between the front joint of right or left leg and the back joint of right or left leg.

3.4. Robot motion

The robot body is modeled as a rectangle, and its center of mass is assumed to be lied at the center of the rectangle. The robot body is assumed to be moved in the quasi-static constant-velocity with forward motion without any pitch, and dynamics of the swing leg are ignored due to its low inertia compared to that of the body. In addition, the foot is the only portion of the robot to make ground contact during movement, like that of octalegs animals in general.

4. DESCRIPTION OF PARTS

4.1 Adjustable frame

The main feature of this robot is adjustable steel frame. We can adjust the length of the robot with respect to stair size.

Figure 5: Adjustable frame

4.2 Platform

This platform is used to carry the materials up and down. It is made by steel or wooden board attached to the frame. In the figure below, Black color line representing the area for the platform where wooden or steel board is supposed to be attached. Platform form is adjustable so according to load platform could be selected. Upper rectangle is used as platform to carry weight.

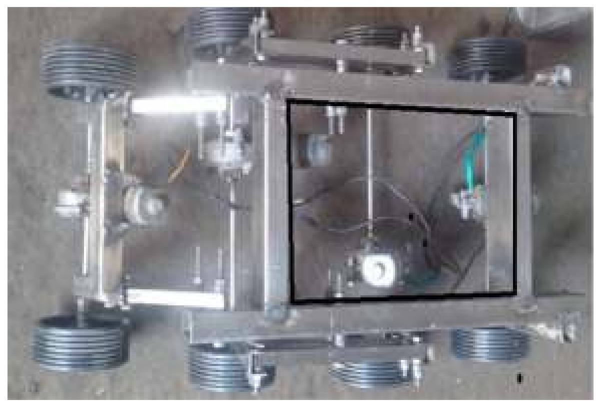

Figure 6: Platform of robot

4.3 PARTS SPECIFICATIONS TABLE:

Part	Specification	Quantity
Steel Square Pipe	10Feet,3/4inches	2
DC Induction motor	12V	6
Battery	12V,1500mah	1
Nut Bolt	M 13	40
Spring	Steel	8

4.4 Wheels

Wheels are made of wax material. This robot has 8 wheels which helps to robot in climbing the stairs. Wheels are designed in PRO E software.

Figure 7.1: Design model of wheel

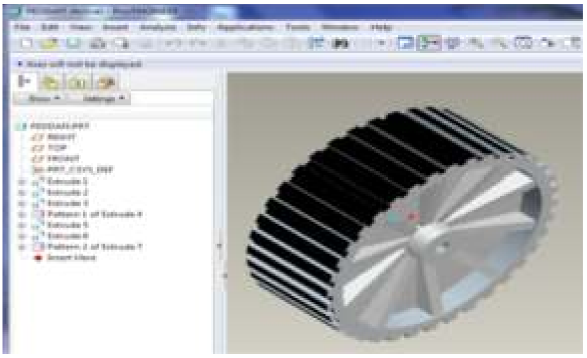

Figure 7.2: Design model of wheel

5. STEPS FOR MAKING THE ROBOT

1. First design the steel frame as per the dimensions with adjustable mechanism.
2. The structure of the robot should be rigid.
3. The five D.C motors are attached to the end of the frame.
4. Four 12v batteries are connected in series for constant movement of wheels.
5. The positive connection is upto12v, and negative connection is up to 6v.
6. Positive connection is for forward motion and negative connection is for backward motion.
7. These connections are linked to circuit board for the robot motion.
8. The robot can be controlled by remote which is connected to circuit.
9. The remote has a switch which is helpful for the backward and forward motion of robot.

6. WORKING OF THE ROBOT

Working of the robot takes place stepwise. The robot comes to rest momentarily after each step. The four steps for climbing the stairs are

1. Robot wheel touches the step
2. Lifting the front part.
3. Lifting the back part of the robot.
4. Following the above steps the robot proceeds.
5. It can also be used for descending of steps.

6.1 Robot wheel touches the step

Initially the robot is in horizontal position and when the robot touches the first step, the upper wheel is ready to move upward to lift the front part of the robot.

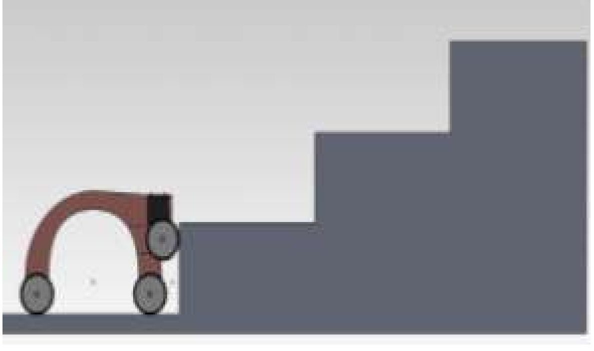

Figure 8: Robot is in initial position

6.2 Lifting the front part

By switching on, the motor starts rotating the upper wheel which lifts the front part of the robot to a certain height. The front wheels will move forward through the step and also helps the robot to climb the stair.

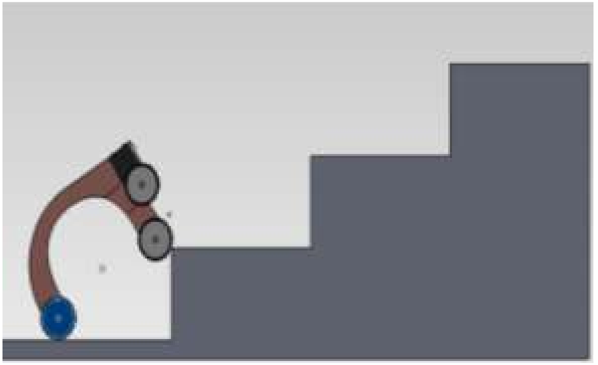

Figure 9: Lifting the front part.

6.3 LIFTING THE BACK PART OF THE ROBOT:

After lifting the front part of the robot, the rear wheel touches the step and moves forward. After climbing all the steps, it will reaches to its initial position.

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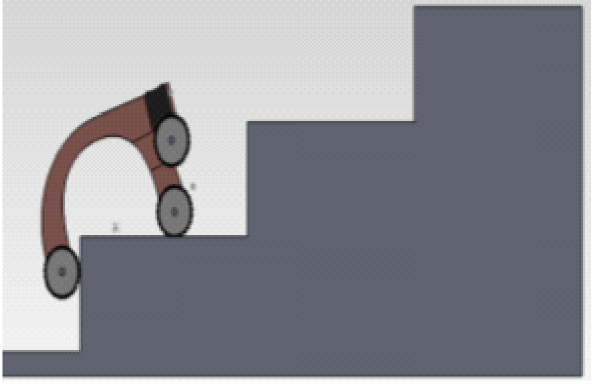

Figure 10: Lifting the rear part of robot

7. FULL WORKING MODEL IMAGES:

Figure 11: Stair climbing of robot

Figure 11.1: Stair climbing of robot

CONCLUSION AND FUTURE SCOPE

We reported on the algorithm and mechanism of trajectory planning and eight-leg coordination for quasi-static stair climbing in a quadruped robot. The detailed development is based on the geometrical interactions between the robot legs and the stair. The suitable dimensions of the robot and how these parameters affect the algorithm are demonstrated. In addition, a brief study on the quasi-static stability of the robot shows that stability can usually be maintained, and possible unstable postures can be corrected, using the stable four-leg supporting posture. Finally, the algorithm is simulated and evaluated via experimentation, which confirms that the proposed algorithm is functional. We are currently in the process of developing a feedback mechanism for the algorithm, which will further tolerate much wider geometrical variations of stairs. In the meantime, the dynamics of the system are under investigation.

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