Clinical Research on Foot & Ankle

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A Bipedal Legs, Which in this Context is Analogous to Study Relating, is Employed to Increase Stability

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Abstract

The foot, which can assist with stress absorption while making contact with the ground, is an essential part of humanoid robot locomotion.Walking stability is directly impacted by foot mechanics.The toes of felids are proposed as the basis for a novel foot mechanism.Four bionic modules, each featuring soft pads and pointed claws at its four corners, make upThis foot's capacity to reduce the amount of impact felt when the foot lands on the ground and extend the duration that the foot is in touch with the ground can improve the robot's adaptability to diverse ground surface conditions with variable degrees of stiffness. The fundamental framework of the bionic module consists of a four-bar linkage with a slide way and a spring. The length of the four-bar linkage and the placement of the claw when inserted into soft ground are also tuned to improve stability and buffering performance. Simulations have proven the validity of the suggested foot mechanism.

Keywords: Leg ; Bionic; Knee

Introduction

Artificial limbs technology has grown tremendously, combining the advantages of many common animals into tools or equipment that people may utilise.In particular, humanoid robots can operate in their place and carry out potentially hazardous tasks.A small support polygon and a high centre of mass (CoM) produce a narrow stability margin.Therefore, many scholars have worked to determine ways to control the speed of humanoid robots.Some researchers have proposed that torso position compliance (TPC), which uses controllers to improve stability, can alter the center of mass (CoM) using zero-moment point (ZMP) error. The model ZMP controller makes use of torso angular acceleration to make up for ankle torque errors [**1**,**2**]. Admission controls the foot's position and posture so that the actual wrench is close to the target wrench. Due to their reliance on criticism, these regulators frequently exhibit slow reaction times and low compensation. A few researchers have made the decision to develop functional mechanisms to boost robot stability during this time. A heel and toe-equipped anthropomorphic landing and takeoff foot has been proposed. A foot with an arch and a toe is designed to absorb impact and resembles an individual's forefoot in its launch. In order to enhance walking dependability and absorb the impact of walking, it is recommended to have a level foot and damping segments made of elastic. Additionally, it does not require additional foot trajectory planning and is extremely adaptable. Honda's Asimo, HRP-2 from AIST and Kawada Ventures, Sony's primary running biped QRIO, Wabian-2R from Waseda College, LOLA from Ludwig Maximilians College, and the Korean robot HUBO from KAIST are notable examples of legged robots [**3**-**6**].

The hallux and passive heel of LOLA's foot have a shock absorber to help reduce shock. This particular foot is capable of ensuring proper ground contact on a variety of surfaces. However, there is a non-linear relationship between the hydraulic damper's force and the amount of stretching. The WABIAN-2R robot walks more like a human because it can move its waist to extend its knees while walking to avoid singularity. Toe-bending is also made possible by the passive joint in the foot. The toe joint is selected as the passive joint based on human gait analysis findings. The toe muscles aren't working as hard in this case, and they rarely provide power for toe motion. However, the robot cannot withstand shock [**7**]. A humanoid foot made by the Italian Institute of Technology replicates the three primary functions of the human foot: adjusting to the shape of the ground, absorbing impacts, storing and exchanging energy, and so on The BHR-2 is designed with a flexible strolling foot. The use of rubber bushes and pads cushion the impact of walking. BHR-5 uses brand-new foot pads to improve the robot's stability and dependability. These efforts concentrated on designing new soles that would lessen the impact of walking, accommodate landing motions, and prevent sliding. Pneumat-BB has a novel robot foot with a human-like deformable arch and the ability to generate windlass and truss mechanisms. With pneumatic actuators, it imitates the links, joints, and muscles of the human foot. On the other hand, the pneumatic robot only weighs 11 kilograms [**8**,**9**]. As a outcome, the load performance of the foot and the humanoid robot as a whole must be further evaluated. The middle of the foot, appropriately streamlined in accordance with the skeletal structure of the human foot, forms an arch that provides the bionic foot with some power for buffering and the capacity to store energy from deformation. The one-of-a-kind material used in the mechanical foot also provides excellent padding; However, it has less of an effect-reducing effect than the human foot.

The primary focus of the initial research on humanoid robot motion planning and control was bicycle locomotion. Despite the fact that robots are able to reliably walk, their dynamic locomotion is still challenging in comparison to that of humans. A few of the many issues that remain in this field include the generation of trajectories in complex environments, rapid running and walking, sudden turning, and walking on rough terrain. During the single-leg support phase, one leg touches the ground while the other swings from behind to front. As a outcome, the humanoid robot yaws around the supporting leg. The robot can't stroll in an orderly fashion in light of the fact that

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the main power that adjusts the turn of the swinging leg is grinding between the supporting leg and the ground. Due to the impact force exerted by the ground, the robot slides with relative ease. Additionally, when the swing leg makes contact with the ground, the mechanism and planning are unable to adequately reduce the impact force from the ground, which frequently causes damage to the rigid structure [**10**]. Despite the robotic foot's intention to imitate the human foot's anatomical structure and primary functions, the foot's structure is extremely complex, increasing the likelihood of error.

Structure of Bonics

It is clear that bionic thought is responsible for a number of significant advancements in science and technology. The best animals survive after millions of years of natural selection and the "survival of the fittest." They are able to easily survive in the wild because of a variety of distinctive characteristics. We came to the realization that, rather than a single factor, multiple factors interact to produce distinct biological characteristics as bionics technology advanced.

In the wild, cats are adept predators, with some reaching the top of the food chain. Cats have developed excellent predation skills over time. They silently approach their prey and then accelerate quickly while hunting. The feline's feet make it easier for it to finish the hunting task. The steps listed below are necessary for hunting. As close to the target as possible, the cats reduce the impact and sound of the foot striking the ground. To complete the final kill, the cat must accelerate to its maximum speed as soon as it is sufficiently close to the target. To get off to a quick start, the foot needs a good grip.

Cats have a remarkable ability to eat other animals because of a combination of factors. The foot requires soft "pads" and an elastic claw in addition to strong leg muscles, high-toughness ligaments, and delicate high-toughness bone structures. The "cushions" on a cat's feet have areas of strength for a limit that provide padding and execution, while the calfskin of the "cushions" protects the foot. The "pads" can withstand impact with the ground. To hold the ground and the hook back from making an excess of commotion and vibration, the paw withdraws at the same time. The claw has sufficient grip at the beginning of the sprint. It grows roots in the earth. Plantar "pads" simultaneously dissipate a significant impact from the ground to the soles of the feet. The "pads" significantly shield the cat's bones and other organs.

The digital flexor tendon is located at the base of the foot, and the claws are on the third knuckles. The flexible ligament pulls the third knuckles into the middle phalanx as soon as the snares fade. In the feline leg flexor recoil, the tensioning ligament that drives the third knuckles expands the hooks, assuming the toes. Paws that self-stretch can be made along these lines. A humanoid robot's foot must also have "pads" and claws that can buffer, stretch independently, and grip.

The score bar is liable for connecting with the ground. The claw's ability to penetrate the ground improves grip. The bionic mechanism is connected to the foot via the fixation rod. The interfacing bar links the hook to the score pole. This is typically how the bionic mechanism's claw always penetrates the ground. When the humanoid robot with this type of foot walks for an indefinite amount of time on hard marble or the landing area, the hook gets damaged and loses its ability. In order for the robot's claw to protect it when it walks on hard ground, it needs to be able to shrink. A restricted block restricts paw and interface bar development in relation to the score bar, and a slide is added to the score bar to make it possible for the interface pole's farthest limit to slide. As a ***outcome***, the claw changes its posture to protect itself. Flexible blocks close to the end of the slide can allow a restoring to the slider to return to the hidden position without being restricted by a confined block right when the assistance foot makes some distance beginning from the initial stage.

Discussion

The robot's walking path can be simulated with either a flat foot or a foot with four bionic mechanisms. demonstrates the humanoid robot's lateral offset and walking friction force. The center of the robot's mass is roughly at the humanoid robot's centroid because the robot's mass is primarily concentrated in the weight above the hip. In order to maintain stability while strolling in an orderly fashion with the left foot and right foot again touching the ground, the focal point of mass (CoM) is controlled to move from side to side. The lateral position of the trunk, which is an approximate representation of the center of mass, is depicted in the upper subfigure. oscillates close to zero, varying with the step frequency. When the left foot is in a positive horizontal position, for instance, it serves as the primary supporting leg. When the grating power is zero, as shown in the lower subfigure, the left foot swings in the air. Particularly on the second and third foot appearances, the foot's grinding powers are more unmistakable with the bionic framework than without it. A slight lateral offset occurs when walking straight because the greater friction is able to resist the torque produced by the swinging leg. The humanoid robot's lateral offset is reduced to less than 0.2 centimeters by the bionic mechanism. However, the lateral offset is greater than 2.5 cm without the bionic mechanism. The bionic mechanism's increased friction force reduces the humanoid robot's lateral offset significantly, enabling the achievement of the stability improvement objective.

Conclusions

A novel humanoid foot with four bionic mechanisms on each corner is proposed in this paper. The bionic mechanism, whose fleshy pads and retractable claws improve traction and cushioning capabilities, was inspired by a felid. The bionic mechanism, which uses springs to self-recover and protect the claw from hard ground, consists of a slider and a four-bar linkage. The proposed foot might be better at buffering and stabilization. Finally, dynamic simulation has demonstrated the practicality of the foot mechanism.

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