ISSN 2231-3842 (Print) ISSN 2277-8691 (Online)

MIRACULOUS-SHELL

Helps in converting Human into Superhuman

Akshay Raj
Research Scholar
Research & Development
IIMT IET

Sumit Kumar
Research Scholar
Research & Development
IIMT IET

Vaibhav Sharma
Research Scholar Research
& Development IIMT IET

Abstract :

For over a century, technologists and scientists have actively sought the development of a type of shell and orthoses designed to augment human economy, strength, and endurance. While there are still many challenges associated with this Shell and orthotic design that have yet to be perfected, the advances in the field have been truly impressive.

Introduction:

- This project helps our soldiers', labours, ward boys by boosting their strength to carry impossible loads and dart across the field at incredible speed. This shell will also provide enhanced mobility and protection against getting injured while carrying heavy loads out of their capability.
- The primary objective of this project is to create a self-powered Shell for strength and endurance enhancement of humans that is ergonomic, mechanically robust, light weight and durable.
- This Shell is designed around the shape and function of the human body, with segments and joints corresponding to those of the person it is externally coupled with.
- The main function of this Shell is to assist the wearer by boosting their strength and endurance. They are commonly designed for military use, to help soldiers' carry heavy loads both in and out of combat. In civilian areas, similar this Shell could be used to help fire fighters and other rescue workers survive dangerous environments. The medical field is another prime area for this Shell technology, where it can be used for an assist to allow ward boys to move heavy patients. Miraculous-Shell could carry a heavy load, while feeling only a few-pound load.

Literature Review :

The Miraculous-Shell is a system which is worn by the human user. It has external structural mechanism with joints and links correspond to those of the human body. It is a kind of a man-machine system centred by the human user. Since this Shell combines the intelligence of human user and the power of machine, it enhances the machine intelligence and power of the human user.

Technology Involved:

Devices that act in parallel with a human limb to increase human locomotory economy, augment joint strength, and increase endurance or strength.

Such biological strategies have inspired designers of running track surfaces and wearable devices such as shoes and shell.Acompliant running track can improve performance by increasing running speed by a few percent and may also reduce the risk of injury.

A carbon composite elastic midsole to improve shock absorption and metabolic economy at moderate running speed. Although metabolic economy improved when runners used this elastic shoe rather than a conventional shoe design without an elastic midsole, the advantage was found to be modest. Such a parallel mechanism would not increase limb length. Each leg spring is designed to engage at foot strike to effectively transfer the body's weight to the ground and to reduce the forces borne the stance leg during each running stance period. Fibreglass leaf springs that span the entire leg, and is capable of transferring body weight directly to the ground during the stance period.

When hoppers utilized external parallel springs, they decreased the mechanical work performed by the legs and substantially reduced metabolic demand compared to hopping without wearing this Shell.

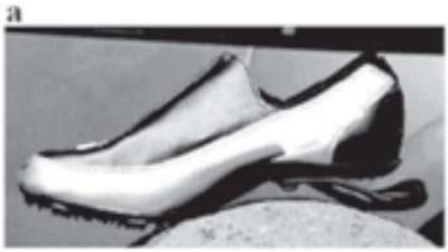


Figure 1: Shoes and shell that act in series with the human lower limb.

Figure 2: Exoskeletons that act in parallel with the human lower limb for load transfer to the ground.

Parallel-limb exoskeletons have also been advanced to augment the load-carrying capacity of humans. This type of leg exoskeleton could benefit people who engage in load carrying by increasing load capacity, lessening the likelihood of leg or back injury. Three degrees of freedom (DOF) at the hip, one at the knee, and three at the ankle. Of these, four are actuated: hip flexion/extension, hip abduction/adduction, knee flexion/extension, and ankle flexion/extension. Of the non-actuated joints, the ankle inversion and hip rotation joints are spring- loaded, and the ankle rotation joint is free-spinning.

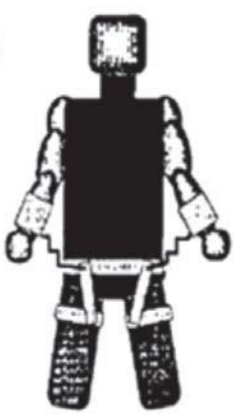
Interesting features of the kinematic design of the exoskeleton include a hip “rotation” joint that is shared between the two legs of the exoskeleton, and therefore, does not intersect with the wearer’s hip joints. Similarly, the inversion joint at the ankle is not co-located with the human joint, but is set to the lateral side of the foot for simplicity. The other five rotational DOF’s of the exoskeleton coincide with the joints of the wearer. This type of Shell and orthotic device does not transfer substantial load to the ground, but simply augments joint torque and work. This type of leg exoskeleton could improve walking and running metabolic economy, or might be used to reduce joint pain or increase joint strength in paralyzed or weak joints.

This Shell to improve performance by increasing the user’s capacity to lift and press large loads has been demonstrated.

To test whether it is indeed possible for this Shell to amplify endurance using this strategy, researchers conducted an experiment on six human subjects each wearing a simple Shell comprised of two springs that connected each wrist to a waist harness (see Figure). The springs were in equilibrium when both elbows were fully flexed with the wrists positioned at chest height. With this mechanism, a subject performed the following cyclic activity until complete exhaustion using a given spring stiffness. From a sitting position, a subject fully extended his arms to grasp a pull-up bar directly overhead, stretching the arm springs. With the assistance of the stretched springs, the subject lifted his body upwards with his arms until his chin cleared the bar. Then the subject stood on the seat of a chair, released the bar, and sat down on the chair. Note that the cycle did not include lowering the body with the arms after pulling up.

Using this approach, energy was only stored in the springs by extending the arms upward. Each subject performed the experiment five times with a given spring stiffness using a total of five different spring stiffness. The order in which spring stiffness were used was randomized to rule out any sequential effects. In addition, each subject was required to use the same time to sit down after pulling up so that the time in which the arms were not being used during each cycle did not change. Between experiments, a subject was given two to three days of rest. The experimental results are shown in Figure. The endurance was maximized around K ~0.25 for each subject. Further, the endurance with an exoskeleton increased by 1.5-fold to 2.5-fold compared to the endurance when no exoskeleton assist was employed. Using a mathematical model of the human arm and Shell, researchers related overall muscle efficiency to this Shell stiffness. The model predicted that muscle efficiency was maximized at the same dimensionless stiffness where endurance reached its maximum (K~0.25 in Figure), suggesting that the endurance changes were a consequence of changes in the efficiency with which the body performed the required work for each cycle. There are many applications for this class of Shell. For example, a crutch was constructed with an orthotic elbow spring to maximize the endurance of physically challenged persons in climbing stairs and slopes.

a



b

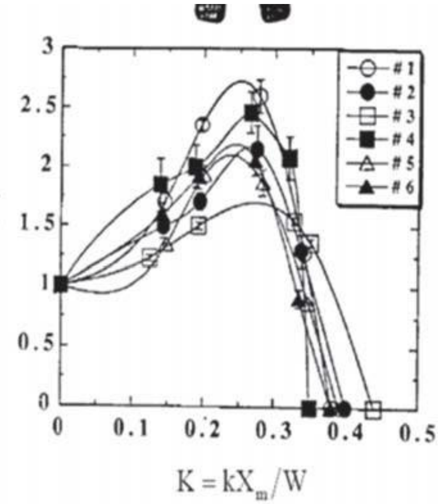


Figure 3 : Miraculous-Shell that act in parallel with a human limb for endurance augmentation.

DESIGN CHALLENGES AND FUTURE DIRECTIONS

Although great progress has been made in the century long effort to design and implement robotic Shell and powered orthoses, many design challenges still remain. Remarkably, a portable leg Shell has yet to be developed that demonstrates a significant decrease in the metabolic demands of walking or running.

Current devices are often both unnatural in shape and noisy, factors that negatively influence device cosmesis.

Electroactive polymers have considerable promise as artificial muscles, but technical challenges still remain for their implementation. These challenges include improving the actuator's durability and lifetime at high levels of performance, scaling up the actuator size to meet the force and stroke needs of this Shell orthotic devices, and advancing efficient and compact driving electronics.

Another factor limiting today's Shell and orthoses is the lack of direct information exchange between the human wearer's nervous system and the wearable device. Continued advancements in neural technology will be of critical importance to the field of wearable robotics.

Current orthotic devices are also limited by their mechanical interface. Today's interface designs often cause discomfort to the wearer, limiting the length of time that a device can be worn. It is certainly an achievable goal to provide comfortable and effective mechanical interfaces with the human body.

Athletes to run marathons, compete in the Ironman Triathlons, and even climb Mount Everest. One strategy employed in the fabrication of modern prostheses is to digitize the surface of the residual limb, creating a three dimensional digital description of the residual limb contours. Once the amputee's limb has been scanned, their geometric data are sent to a computer aided manufacturing (CAM) facility where a new prosthetic socket is fabricated rapidly and at relatively low cost.

In the future such file-to-factory rapid processes may be employed for the design and construction of this Shell and orthotic devices. Offering full protection of these components from environmental disturbances such as dust and moisture. Once designed, device construction would unite additive and subtractive fabrication processes to deposit materials with varied properties (stiffness and density variations) across the entire Shell volume using large scale 3D printers and robotic arms.

Shell and the Future of Mobility

During the 20th century, investments in human-mobility technology primarily focused on wheeled devices. Relatively little investment was focused on the advancement of anthropomorphic Shell technologies that allow humans to move bipedally at enhanced speeds and with reduced effort and metabolic cost. It seems likely that in the 21st century more investments will be made to drive innovation in this important area. The fact that large automo- bile companies, such as Honda and Toyota, have recently begun this research programs is an indication of this technological shift. That would allow the elderly, the physically challenged and persons with normal intact physiologies to achieve a level of mobility not yet achieved.

Application:

- In industrial use for loading and unloading goods.
- In Military areas for carrying heavy loads and mountaineering.
- In Civilian areas used to help fire fighters and other rescue workers survive dangerous environments.
- In Medical field, it can be used to assist ward boys to move while carrying heavy patients.

Future scope:

This project can be converted to full suit Miraculous-Shell for upper and lower limb which will help disable person to walk and lift the objected its own. The vision for the device is that it will provide a versatile transport platform for mission-critical equipment. This Shell will be used in Industrial areas, Medical field, Civilian areas and Military areas.

References:

1. Cavagna GA, Heglund NC, Taylor CR: Mechanical work in terres-trial locomotion: two basic mechanisms for minimizing energy expenditure. Am J Physiol 1977, 233:R243-R261.
2. Ker RF, Bennett MB, Bibby SR, Kester RC, Alexander RM: The spring in the arch of the human foot. Nature 1987, 325:147-149.
3. Alexander RM: Elastic Mechanisms inAnimal Movement Cambridge:Cambridge University Press; 1988.
4. Blickhan R: The spring-mass model for running and hopping. J Biomech 1989, 22:1217-1227.
5. McMahon TA, Cheng GC: The mechanics of running: how does stiffness couple with speed? J Biomech 1990, 23(suppl 1):65-78.
6. Farley CT, Glasheen J, McMahon TA: Running springs: speed and animal size. J Exp Biol 1993, 185:71-86.
7. Hogan N: Skeletal muscle impedance in the control of motor actions. Journal of Mechanics in Medicine an Biology 2002, 2(3):359-373.
8. McMahon TA, Greene PR: The influence of track compliance on running. J Biomech 1979, 12:893-904.
9. KerdokAE, BiewenerAA, McMahon TA, Weyand PG, Herr H: Energetics and mechanics of human running on surfaces of different stiffnesses. J Appl Physiol 2002, 92:469-478.
10. Herr H, Gamow RI: Shoe and foot prosthesis with bending beam spring structures. U.S. Patent 5,701,686 1997.
11. Herr H, Gamow RI: Shoe and foot prosthesis with bending beam spring structures. U.S. Patent 6,029,374 2000.
12. Dick J, Edwards E: Human Bipedal Locomotion Device. U.S. Patent 5,016,869 1991.
13. Yagn N: Apparatus for facilitating walking, running, and jumping. U.S. Patent 420179 1890.