"Artificial Exoskeletons"

The Future is Bionic...

I have always fascinated about the powers of the **Bionic man**. Bionic man is a very wide term whose pinnacle would be to create an **artificial human being**. Today research in that area is progressing an example of that is the *stem cell*. But talking about that would be science-fiction. So lets talk about something more *real*.

...so what about the present?

Have you seen science fiction movies like Avatar, G.I Joe or Iron Man? They wear a suit that enable them to **lift extremely heavy objects**, **run at great speeds**, and even **fly**, among other things (Iron Man also had a power source in the suit that kept him alive but that does not interest us); Do you think such things could really exist, today?

Yes, it happened **last year at IIT**. I was amazed when I saw people wearing a **mechanical exoskeleton** and jumping over a entire car in a single leap! During Techfest 2009 a team of performers called "**3Run**" from UK displayed a stunning performance! Two of them were wearing exoskeletons (3Run doesn't mention this on their website) which I believe looks just like the ones produced by PowerSkip, a German company.

In the past ...

The first exoskeleton was co-developed by General Electric and the United States military in the 1960s, named **Hardiman**, which made lifting 250 pounds (110 kg) feel like lifting 10 pounds (4.5 kg). It was impractical due to its 1,500 pounds (680 kg) weight. The project was not successful. Any attempt to use the full exoskeleton resulted in a **violent uncontrolled motion**, and as a result it was never tested with a human inside. Further research concentrated on one arm. Although it could lift its specified load of 750 pounds (340kg), it weighed three quarters of a ton, just over twice the liftable load. Without getting all the components to work together the practical uses for the Hardiman project were limited.[Hardiman, Powered Exoskeleton]

While these technologies seem over the horizon in terms of the current mechanical and material sciences, DARPA is actively pursuing a $50-million program "**Concepts of Operations for Exoskeletons for Human Performance Augmentation** (EHPA)" to develop them. Some of them have already moved into prototype stage.[EHPA]

Powered Exoskeletons

A powered exoskeleton is a powered mobile machine consisting primarily of an exoskeleton-like framework worn by a person and a power supply that supplies at least part of the activation-energy for limb movement. Working examples are also starting to be used for **medical, military** and **industrial purposes** but are not currently widely deployed [BLEEX]. Various problems remain to be solved, including suitable power-supply.[Powered Exoskeleton]

Applications

- Powered exoskeletons are designed to **assist and protect** soldiers and construction workers.
- To aid the survival of people in other **dangerous environments**.
- A wide **medical market** exists in the future of **prosthetics** to provide mobility assistance for aged and infirm people.
- Other possibilities include **rescue work**, such as in collapsed buildings, in which the device might allow a rescue worker to **lift heavy debris**, while simultaneously protecting him from falling rubble.

Illustration 1: The Berkeley lower extremity exoskeleton can be used to augment soldiers' ability to carry heavy equipment for long periods of time.

Science

Just like **prosthesis** is a device that substitutes for a missing part of a limb, **Orthoses** are a limited, **medical form of exoskeleton**. An **orthosis** (plural orthoses) is a device which attaches to a limb, or the torso, to support the function or correct the shape of that limb or the spine. **Orthotics** is the field dealing with orthoses, their use, and their manufacture. Sciences such as **materials engineering, gait analysis, anatomy and physiology, and psychology** contribute to the work done by orthotists. **Applications:** Individuals who benefit from an orthosis have sustained a physical impairment such as a **stroke**, **spinal cord injury**, or a **congenital abnormality** such as spina bifida or **cerebral palsy**.[Orthotics, Artificial Exoskeletons]

Current Technology[Powered Exoskeleton, Exoskeletons]

Here I wish to summarize some of the best exoskeletons in the world:

- Cyberdyne's HAL5 arms/legs, allows the wearer to lift 5 times they normally could.

- UC Berkeley/Lockheed Martin, HULC legs, allows the user to carry up to 200 lbs on a backpack attached to the exoskeleton independent of the user.
- **T-52 Enryu Rescue Exoskeleton** A 5 ton 10 foot high hydraulic exoskeletal mechanism for cutting through debris after a disaster such as an earthquake.
- **Panasonic Inflatable Exoskeleton** is designed to help patients recover from partial paralysis. Sensors at the elbow and wrist allow a healthy arm to control the eight artificial muscles, which are powered by compressed air, on the paralyzed side.
- Artist, Stelarc is renowned for his augmented body art forms. Here he has built a **giant spider** like walking frame.
- The Human Neuromechanics Laboratory at the University of Michigan is devoted to the interaction between the nervous system and bone and muscles. It produces exoskeletal systems that a directly **controlled by the brain** - real life bionics.
- This exoskeletal '**springwalker**' allows its wearers to gamble along at 35 miles an hour and to leap 5 feet into the air.
- Atsuo Takanishi, an engineering professor at Tokyo's Waseda University developed this system as a potential **replacement for wheelchairs**, allowing its users to navigate up and down stairs.
- Lifesuit Sapergo **Robogames** 2007 included an exoskeletal weight lifting contest. Watch the video at http://www.youtube.com/watch?v=uFJiUQnJJ94

Illustration 2: T-52 Enryu Rescue Exoskeleton A 5 ton 10 foot high hydraulic exoskeletal mechanism for cutting through debris after a disaster such as an earthquake.

References

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