Human Augmentation with Robotics

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Abstract- Human augmentation with robotics is a rapidly evolving field that merges the advancements in robotics and bioengineering to enhance the capabilities of the human body. This interdisciplinary domain encompasses various areas such as prosthetics, exoskeletons, brain-computer interfaces, and sensory augmentation. By seamlessly integrating robotics into human physiology, researchers and engineers strive to overcome physical limitations, enhance cognitive abilities, and improve overall human performance. This paper provides a comprehensive overview of the key concepts, current developments, and potential implications of human augmentation with robotics.

Keywords: ***Human augmentation, robotics, prosthetics, exoskeletons, brain-computer interfaces, sensory augmentation, physical enhancement, cognitive enhancement, performance improvement***

INTRODUCTION

One trait distinguishing human from all other species on Earth is our capacity to create novel innovations, such as equipment, fire, the wheel, language, the printing process, television, radio, computers, social networking sites, the Internet, etc. Technology enhances human skills by enabling actions that people previously could not execute. As a result, how people interact with their surroundings and grow is altered. Technology is developed by human civilization, and technology changes the course of human history. Any procedure or addition that makes something greater or more effective is referred to as augmentation.

HUMAN AUGMENTATION AND ITS TYPE

The study of methodologies, technologies, and applications for improving human perception, action, and/or cognitive capacities is known as human augmentation. Artificial intelligence (AI) techniques, information fusion and fission, and sensor and actuation technologies are used to accomplish human augmentation.

They are broadly classified into three types
1. Augmented Senses.
2. Augmented Action.
3. Augmented Cognitive

1. Augmented Senses - By evaluating accessible multimodal data and sending data to the human through specific human senses, augmented senses are achieved. There are several subclasses for enhanced vision, hearing, haptic feeling, smell, and taste.
2. Augmented Action - By evaluating human conduct & mapping it to behaviours in adjacent, remote, or virtual surroundings, enhanced action is achieved. Subclasses include things like motor augmentation, enhanced force and motion, speech input, gaze-based oversight, teleportation, remote existence, and others.
3. Augmented Cognitive - Identification of the user's cognitive state, accurate interpretation of utilizing analytical tools, and customization of the computer's reaction to satisfy both the user's present and future needs constitute augmented cognition.

Human Augmentation in Robotics

Engineering's field of robotics deals with the creation, design, production, and use of robots. The goal of the robotics industry is to develop artificial intelligence that can help people in a variety of ways. The fundamental objective of research in robotics has been to develop machines that can collaborate with humans on demanding tasks. The use of robotic technology to improve human skills, either physically or intellectually, is referred to as "human augmentation with robotics." from healthcare to entertainment, this young area has the potential to revolutionize many facets of our lives. Current interest is in the so-called wearable robots, a type of robotics system that is worn and directly operated by the human operator. The robotics community is now very interested in the so-called wearable robots, a type of robotics system that can be worn & directly controlled by the human operator. The development of robots that are capable of sharing demanding workloads with people has been one of the key objectives of robotics research.

HUMAN AUGMENTATION FOR PROSTHESIS AND EXOSKELETON

A prosthesis is a man-made device that replaces a lost body component. This missing portion might have been lost as a result of trauma, disease, or a congenital ailment. Prostheses are intended to restore the lost functioning of a missing bodily component. In general, an interdisciplinary team of physiatrists, prostheses, healthcare professionals, and occupational therapists handles amputee rehabilitation. Prostheses can be constructed by hand or with a computer-aided design (CAD), which is a software program that allows designers to plan and assess production utilizing analysis and optimization tools, as well as computer-generated 2-D and 3-D graphic. A robotic exoskeleton is a mechanical device that a person wears for certain functions or applications. An exoskeleton is often a rigid mechanical framework with joints that allow human operators to move. Exoskeletons are devices that are worn that aid in movement or expand the capability of the body. Methods of augmented actions relate to the various ways in which people might improve their physical or cognitive skills by utilising technology. These approaches can be divided into two types.

1. Prosthesis
2. Robotic exoskeleton

Prosthesis of the Limbs-A prosthesis is a man-made substitute for a missing body component. Artificial arms and legs are the most commonly regarded as prosthesis, while artificial eyes, and tooth structures, as well as a replacement for bones, arteries, and heart valves, are also correctly referred to as prosthesis. When it comes to robotic implementation, there are two types Prosthesis for the upper and lower limbs.

Upper Limb Prosthesis- Upper-extremity prosthesis are utilised at various levels of amputation: forequarter, shoulders disarticulation, trans humeral prosthesis, elbows disarticulation, trans-radial prosthesis, wrists disarticulation, complete hand, partial hand, finger, and partial finger. A trans-radial prosthesis is an artificially created limb that replaces a lost arm below the elbow. Upper limb prostheses can be categorized in three main categories: Passive devices, Body Powered devices, and Externally Powered (myoelectric) devices.

Passive devices-Passive devices can be passive hands, which are mostly utilized for aesthetic purposes, or passive tools, which are primarily used for certain activities (e.g., leisure or vocational). A passive device can be static, which means it has no moveable elements, or adjustable, which means its configuration can be changed (e.g., flexible hand opening). Despite the lack of active gripping, passive devices are extremely beneficial in bimanual activities that need object fixation or support, as well as gesticulation in social contact

Body Powered devices-In Body Powered devices a harness and cable are wrapped across the opposite shoulder of the injured arm to operate powered or cable-operated limbs. Body-powered technique investigates the use of the user's breathing to supply energy and operate the prosthetic hand, potentially eliminating the need for an actuation cord and harness.

Externally Powered (Myoelectric) Devices -
Myoelectric arms are type a of prosthetic device. These function by sensing when muscles of the upper part of the arms move, causing a prosthetic hand to open or close through electrodes. A trans-radial prosthetics arm is frequently referred to as a "BE" or below elbows prosthesis in the prosthetics business.

Lower Limb Prosthesis-Lower-extremity prosthetics mean artificially substituted limbs that are at or below the hip level. Trans-tibial and trans-femoral are the two primary subclasses of lower extremity prosthetic devices.

Transfemoral-A transfemoral prosthesis is a prosthetic limb that replaces a lost leg above the knee. Transfemoral amputees is challenging to restore normal mobility... A trans-femoral prosthetic limb is often known as "AK" or above the knee prosthesis in the prosthetics

Transtibial-A transtibial prosthesis is a prosthetic limb that replaces a lost leg below the knee. Transtibial amputees typically regain normal motion more quickly than transfemoral amputees, owing in large part to the retention of the knee, making it possible for simpler movement. Lower extremity prostheses are artificially substituted limbs that are at or below the hip level. A trans-tibial prosthetic limb is often known as a "BK" or below-the-knee prosthesis in the prosthetics business.

Robotic Exoskeleton-Exoskeletons are wearable structures that support and assist movement, or augment the capabilities of the human body. Exoskeletons are devices that can assist people, or augment their physical capabilities. Robotic exoskeleton is applicable in hip exoskeleton, knee exoskeleton, and back exoskeleton.

Hip Exoskeleton -The hips are the joints that connect both the upper and lower limbs. Human hips can do flexion-extension, abduction-adduction, & medial-lateral rotation movements (that's three degrees of freedom). To walk or run, a human must perform these actions. The majority of researchers have placed users' exoskeleton actuators onto their hips. The hip exoskeleton device features actuators on both the hip and the knee and was developed to allow the user to flex the hip in a variety of ways.

Knee Exoskeleton-Knee exoskeletons are often made with fitted actuators and several sensors to give users with controlled assistance force or torque for user-initiated movement. The human knee is a crucial area of study for scientists because it produces a substantial amount of torque when walking, running, and movements from crouching to standing and back again. Moreover, during certain actions, the knees also reduce impact. The knee is also situated halfway between the hip and the ankle. The knee provides a simpler range of motion than the hip & ankle, including rotational and flexional motions. However, most studies on exoskeletons have only simulated one degree of freedom for the knee exoskeleton, which is solely responsible for moving the knee during flexion and extension motions.

Back Exoskeleton-The most frequent musculoskeletal problems associated with employment are back injuries. An alluring approach to minimize ergonomic risk factors & lessen musculoskeletal loads for workers who undertake to lift is the use of wearable robots. To move a joint, a single muscle may be required, one that passes through many joints. Several researchers have employed a variety of actuators to trigger the joints within the exoskeletons. Several joints can be moved by the actuators. These multiple-joint exoskeletons demand a more complex control system than single-joint exoskeletons because the movement of the joints must be controlled in a way that results in a synchronized stride. These exoskeletons are discussed in this section.

IMPLEMENTATION OF HUMAN AUGMENTATION

The adoption of human augmentation technology necessitates a well-thought-out strategy including a range of stakeholders, including regulators, end users, developers, and academics. The following actions might be taken to implement human augmentation technology:

1. Research and development - are usually the first steps in the development of a prototype or proof-of-concept for human augmentation technologies. To create the technology and evaluate its efficacy, researchers, engineers, and designers must work together.
2. Regulatory Approval - The technology must pass regulatory approval procedures before being deployed in the real world to make sure it is secure and efficient. Obtaining authorization from governmental organisations.
3. Pilot Testing - Following regulatory clearance, a technology may be put to the test in a controlled setting to see if it performs as intended and poses no danger to users. This might entail testing the technology on a select group of people or in a controlled setting.
4. User Training - After the technology has been evaluated and shown to be successful, end users need to be instructed on how to use it successfully and securely. Online courses, user manuals, or practical teaching may all be a part of this training.
5. Deployment - The technology may be used in the actual world when it has been tested and users have received training. The device may need to be installed at businesses, hospitals, or other locations where it will be used.

6. Monitoring and maintenance -are necessary to make sure that the technology is utilized safely and correctly once it has been put into use. It could be necessary to do routine maintenance and updates to maintain the technology current and in excellent functioning condition.

Overall, the use of human augmentation technology necessitates a coordinated strategy that entails cooperation amongst diverse stakeholders and careful attention to legal, moral, and safety issues.

APPLICATIONS OF HUMAN AUGMENTATION

The use of technology to increase or augment human skills is referred to as human augmentation. Here are some examples of human enhancement:

1. Typical Daily Routine Activities: Robotic limbs and an exoskeleton assist a person in carrying out daily activities such as walking, eating, and other activities. Exoskeletons have aided in tasks such as carrying large goods, travelling great distances, and even ascending stairs. These robots are intended to help people in their daily lives by enabling them to perform tasks that would otherwise be impossible for them.
2. Replacing Missing Human Body Parts: A prosthesis is a device that replaces a body component that has been severed, lost in an accident, or is missing from birth. As part of their cancer, diabetes, or critical illness treatment, or a lost limb
3. Healthcare: Prosthetic limbs, exoskeletons, & Brain Computer Interfaces (BCIs) are examples of human augmentation technology that can assist people with physical limitations or injuries. Boost their movement and communication skills. Robotics can also be utilised to automate procedures such as surgery and drug delivery in hospitals and clinics.
4. Manufacturing: Robotics can be used to automate repetitive and risky manufacturing operations like as welding, painting, and assembly. Exoskeletons and other human augmentation technologies can also assist workers in lifting and moving big goods, minimising the risk of damage.
5. Agriculture: In agriculture, robotics can be utilised for operations that include planting, harvesting, & crop monitoring. Human augmentation technologies like smart glasses can also assist farmers in monitoring crop growth and identifying potential problems.
6. Military: Exoskeletons and other human enhancement technologies can improve soldiers' physical capabilities, enabling them to move more rapidly and carry larger loads. Additionally, robotics can be utilised for missions like bomb disposal & reconnaissance.
7. Education: By giving students access to immersive and interactive environments, human augmentation technologies like virtual and augmented reality can improve the learning process. Students can learn about programming and engineering with robots.
8. Industrial use: Wearable robots have long been employed in industrial settings, and these devices are only growing better. One illustration is the Serco's Robotics Power Loader 200X, which enables a person employing it to lift 400 pounds total in each arm for extended periods of time without becoming fatigued, even when carrying big loads aloft or stooping low. Wearable robots have several industrial uses, such as supporting workers who perform repetitive jobs like: Paint spraying Welding Material handling on assembly lines.

Overall, human enhancement & robotics have the promise of enhancing productivity, security, and the standard of life in a wide range of fields and applications.

CONCLUSION

To summarise, human augmentation using robots is a transformative field with enormous promise for improving human skills. Researchers and engineers are pushing the frontiers of what it means to be human by integrating modern robotic technologies with the human body. Prosthetics, the exoskeleton brain-computer interfaces, and sensory augmentation systems have already made significant advances. Individuals who have lost limbs can regain mobility and dexterity, and exoskeleton technologies can provide external support and greater strength for a variety of purposes. Brain-computer interfaces allow for direct contact between the human brain & external devices, bringing up new avenues for directing technology via neural signals. Sensory Human enhancement with robots has the potential to revolutionise healthcare, rehabilitation, & human performance in the future. Individuals can overcome restrictions and achieve incredible feats by unleashing new levels of physical and cognitive skills in which human augmentation with robotics benefits for all of humanity.

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