TECHINICAL SEMINAR REPORT

ON

HUMAN AUGMENTATION: PAST, PRESENT AND FUTURE

Submitted in Partial fulfilment for the VIII Semester, BE, Information Science & Engineering.

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CERTIFICATE

Certified that the Technical Seminar entitled **"Human Augmentation: Past, Present and Future"** carried out by **Ms. B.U.KAVYA, 1GA17IS005,** a bona fide student of VIII Semester, in partial fulfilment for the award of **Bachelor of Engineering** in **Information Science & Engineering,** of the Visvesvaraya Technological University, Belgaum, during the year **2020-2021**. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report. This seminar report has been approved as it satisfies the academic requirements for Technical Seminar (17CSS86) prescribed for the said degree.

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ABSTRACT

Human augmentation is a branch of study aimed at improving human capabilities through medicine or technology. This has traditionally been accomplished by taking chemical compounds that enhance a specific aptitude or by implanting devices that necessitate medical procedures. Both of these augmentation treatments are intrusive. Augmented abilities have also been achieved with external tools, such as eyeglasses, binoculars, microscopes or highly sensitive microphones. Lately, augmented reality and multimodal interaction technologies have enabled non-invasive ways to augment human.

Human Augmentation (HA) spans several technical fields and methodological approaches, including Experimental Psychology, Human-Computer Interaction, Psychophysiology, and Artificial Intelligence. Augmentation involves various strategies for optimizing and controlling cognitive states, which requires an understanding of biological plasticity, dynamic cognitive processes, and models of adaptive systems. Advanced human augmentation allows for a more human-centered approach to technology development. It builds on previous technology concepts including ubiquitous computing, wearable computing, augmented, virtual, and mixed reality, autonomous systems, and ambient intelligence.

Wearable technologies may act as mediators for human augmentation, in the same manner as eyeglasses once revolutionized human vision. Non-invasive and easy-to-use wearable extensions will enable lengthening the active life for aging citizens or supporting the full inclusion of people with special needs in society, but there are also potential problems. Therefore, it is important to consider ethical and societal issues: privacy, social manipulation, autonomy and side effects, accessibility, safety and balance, and unpredictable future.

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CHAPTER 1

INTRODUCTION

Human augmentation (HA) is a field of research that aims to enhance human abilities through medicine or technology. This has historically been achieved by consuming chemical substances that improve a selected ability or by installing implants which require medical operations. Both of these methods of augmentation can be invasive. Augmented abilities have also been achieved with external tools, such as eyeglasses, binoculars, microscopes or highly sensitive microphones. Lately, augmented reality and multi-modal interaction technologies have enabled non-invasive ways to augment human.

Human augmentation is an interdisciplinary field that addresses methods, technologies and their applications for enhancing sensing, action and/or cognitive abilities of a human. This is achieved through sensing and actuation technologies, fusion and fission of information, and artificial intelligence (AI) methods. Fig. 1.1 illustrates some of these paradigms

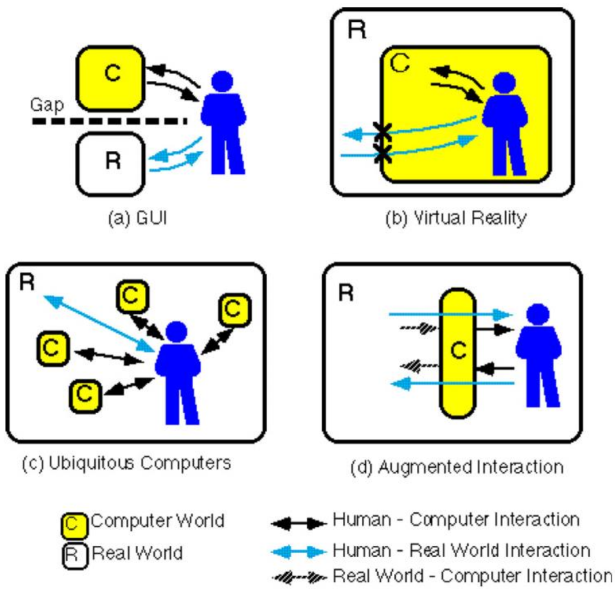

Figure 1.1: Different user interface paradigms

Human-centric user interface paradigms include perceptual inter1faces, augmented reality (AR), virtual reality (VR), and ubiquitous computing. Human augmentation is a paradigm that builds on top of these earlier paradigms by combining the inter1action where human action is the core. These actions are supported with augmenting technologies that are related to perceiving, affecting,

Human augmentation can further be divided into three main categories of augmentation:

Augmented senses (aka enhanced senses, extended senses) are achieved by interpreting available multisensory information and presenting content to the human through selected human senses. Sub-classes include augmented vision, hearing, haptic sensation, smell, and taste.

Augmented action is achieved by sensing human actions and mapping them to actions in local, remote or virtual environments. Sub-classes include motor augmentation, amplified force, and movement, speech input, gaze-based controls, tele-operation, remote presence, and others.

Augmented cognition (aka enhanced cognition) is achieved by detecting human cognitive state, using analytical tools to make a correct interpretation of it, and adapting computer's response to match the current and predictive needs of the user (e.g., providing stored or recorded information during natural interaction).

Wearable interactive technology is an essential component in enabling human augmentation. It can empower the user with non-invasive and easy to use extensions to interact with smart objects and augmented information of the hybrid physical-virtual world of the future. Human augmentation will serve the user by providing essential, timely information for current tasks and filtering out unnecessary information. Artificial intelligence assistants may act on our behalf, according to our behavioral patterns and preferences, carrying out a range of simple and complex tasks efficiently

Crossmodal interaction allows the characteristics of one sensory modality to be transformed as stimuli for another. This can benefit people with disabilities as well as the elderly with deteriorating sensory abilities. Crossmodal interaction can be a strong method to build useful and viable elements of human augmentation. In fact, researchers such as Demattè have already been trying to evaluate how our brain performs crossmodal interaction and how it may be possible to expand the boundaries even further within spontaneous cognitive responses as well as in social-emotional scenarios.

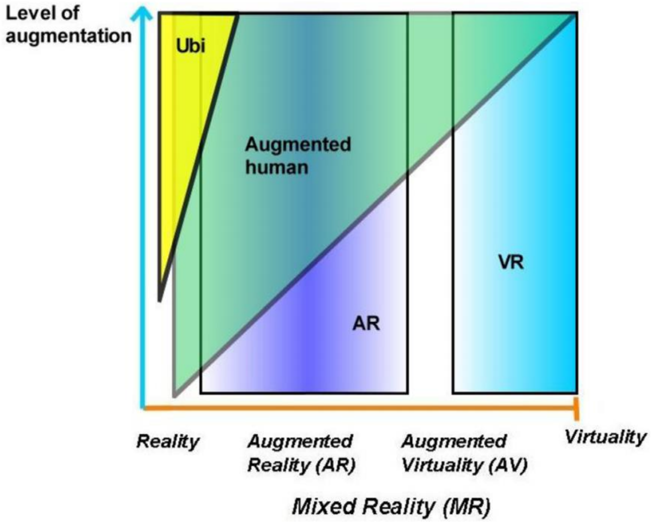

Figure 1.2 : Milgram's virtuality-reality continuum extenstion

Fig. 1.2 shows our extension to Milgram's virtuality-reality continuum where the additional y-axis is the level of augmentation (number of employed sensors or tools, or the level of augmented cognition). Augmented human uses elements from AR, VR, ubiquitous computing and other user interface paradigms, but merges them in novel ways.

Various other concepts and models in computer science, such as ubiquitous computing, perceptual user interfaces, wearable computing, augmented reality, virtual agents, connected devices, robots, and human-computer integration may also provide blueprints for the future in human augmentation. All the concepts and models have a slightly different scope from each other; however, they all focus on different aspects and features of the same augmented-human future.

CHAPTER 2

HA HISTORY AND EVOLUTION

This Section presents a summary of existing human-technology interaction research relevant to human augmentation. It includes examples of different approaches in augmented senses, action, and cognition.

2.1. Augmented senses

Augmented senses use methods and technologies to either compensate for sensory impairments (mostly visual and auditory) or to exceed the capabilities of existing senses. In first case, for example, haptic actuators can be used to describe surroundings to a blind person or speech signals to a deaf person. In the second case, the human senses are augmented by using additional sensors to observe signals beyond normal human sensory capabilities and transforming them to a suitable format for human use. Many technologies can augment human senses beyond their natural limits. Light sensors or tiny cameras could give "eagle eyes" or night vision to the user, or even go far beyond the human vision wavelengths. A classic example is using "x-ray vision" to observe occluded objects.

Recent work in combining gaze interaction and haptic feedback proves that these two modalities can be used in a seamless manner to support user's main goals in wearable interaction. To push forward the technological development of wearable VR/AR glasses, they are recently invented several extensions for them. Proof-of-concept prototype enables users to touch and feel virtual 3D objects without the need for wearable devices. A super-wide field-of-view (FOV) optical design for VR glasses can cover even the full human FOV. There are experiments conducted to extend the FOV of a VR viewing device and providing visual feedback for a smart glass user directly to the retina – surpassing the eye and its lens. A combination of pan-tilt-superzoom and 360- degree cameras can provide a zoomable gigapixel experience for a VR viewer.

Further examples of exciting augmentation technologies include, for example, “haptic eyes” that let the user feel what the camera sees or “aided eyes” that enhance the users’ cognitive abilities by automatically identifying and matching currently viewed objects with previously saved information. Spectral extensions enable humans to see beyond visible light spectrum or to hear sub- or supersonic sounds. Such sensors and cameras can be embedded in AR glasses. Near-infrared (IR) and near1ultraviolet (UV) light cameras can expand the range of human senses. In addition, they are very low-cost. Modern thermal (longwave) IR cameras can also be low-cost and extremely small, and they open intriguing possibilities for various applications such as the ability to see in total darkness without any illumination. Security and safety applications inside and outside of vehicles, offices or homes are also potential mainstream applications for these sensors.

Augmented sense of smell can be achieved by measuring or producing scents. State-of-the-art technologies can measure scents, which are undetectable by human olfaction system, thus improving the ability to “smell” hazardous substances. Combination of odor measurement technologies and artificial intelligence (AI) algorithms can achieve odor detection accuracy beyond human olfactory capacity.

Similar approaches have been developed to augment the sense of taste. Sensors that can identify any given taste as sweet, savory, bitter and sour are relatively easy to build. However, production of taste sensations has proven to be difficult, as it is closely related to the sense of smell and partly it is also a personal experience.

Augmented senses can also enable sensory substitution or sensory prosthesis, in which information from one sense can be mediated through a different sense. This could be done by comparing haptic and audio modalities in order to aid movement and navigation in low-vision environments. More importantly, in extreme environments such as in space, deep in the ocean or buildings that are on fire, the ability of sensors to work in harsh conditions is essential.

Further techniques for building augmented senses include sensors designed for specific uses such as cameras for very dim light or for non-visible spectrum, auditory or vibration sensors within mobile devices or even large-scale sensor arrays, such as networks of remote sensors continuously broadcasting environmental information and global positioning systems for tracking movements of objects and individuals.

2.2. Augmented action

Augmented actions can be performed in cases operating in a hazardous environment and therefore placing a human operator at the site is not safe. Examples of use cases include factories, atomic power plants, assembly operations in space or the sea, and search and rescue operations.

It is also possible to utilize other input methods such as touch, gestures, gaze and speech to augment human actions in VR or in machinery control. Gestures can be used to augment action from distance. Controlling machinery over a distance by a mere wave of the hand or other gesture can appear to an observer as use of telekinetic powers. However, gesture-based augmented movement often triggers a phenomenon named as “Midas Touch Problem”. This means that a user accidentally makes selections and confirmations. One solution to solve the problem is to use a virtual inter1face to mediate gestures. Further, progress in automated speech recognition has enabled more accurate use of voice commands for VR and robotic control. In an ideal case, human-computer speech interaction is adaptive, meaning that the machine can correctly interpret the speech despite the user's capabilities or limitations. . It is also possible to control virtual environments by using gaze or head movement.

2.3. Augmented cognition

Augmented cognition is a form of human-technology interaction where a tight coupling between a user and a computer is achieved via physiological and neurophysiological sensing of the user's cognitive state. Augmented cognition integrates information detected from the user to adapt computer input to match the user's situational needs. From the beginning, augmented cognition has been a multidisciplinary field of research combining expertise from cognitive psychology, neuroscience, computer science, engineering, and HCI.

The ultimate goal of the research is to extend user's cognitive abilities and to seamlessly create a functioning augmented cognition that can easily be used to overcome and accommodate bottlenecks, limitations (e.g., decision making or cognitive overload), and biases in human cognition and information processing chain.

Augmented cognitive abilities include extended memory and virtually unlimited knowledge. This can be achieved by using a centralized network to enable extended cognition. Augmented cognition has already been used to monitor one's health, assist patients suffering from mild brain injuries and enhancing learning and memory. Tools like life-logging (i.e., storing images and pictures to support memory) can be beneficial for augmented cognition.

Most previous studies have concentrated on testing a method to detect cognitive or affective state of the user by using one measurement technique. In neuroscience, methods have been developed to monitor, facilitate, and modulate human brain functioning.

Due to invasiveness and ethical concerns of such methods, other solutions are more popular for human-technology interaction. Wearable sensors can measure, for example, electroencephalography, facial muscle activity or sweat gland activity. These measurements can be used to detect one aspect of cognitive state like workload or confusion reliably.

But in order to achieve a truly symbiotic relationship between human cognition and computer, unimodal methods described above are not sufficient. Instead, multidimensional measurements are needed. This means that several technologies are combined to track down different aspects of human cognitive and emotional functioning.

In real user cases multiple sources of data need to be integrated and interpreted so that the system response works in real time and is context-sensitive. To make the loop between the user and the computer seamless, biocybernetics adaptation and similar methods can be considered. This also means that it is necessary to develop mathematical models order to understand augmented cognition. Artificial intelligence can be used to process vast amounts of sensor data.

Finally, one long-term goal in human-technology interaction is to use the knowledge of human cognition to build machines that can think like humans. Unlike the current implementation of AI systems, hybrid-augmented intelligence does not require large data sample sizes or extensive data modeling and evolution. Instead, utilizing an intelligent data structuring model combining human cognition with machine learning or by creating software and hardware structures mimicking the working of the human brain itself computer's cognitive capabilities could be improved. Even though this type of computing is still in its infancy, such systems can someday improve the safety, reliability, and predictability of complex dynamic decision-making systems. These systems also have the advantage of replicating human thinking, and, thereby, truly expanding human cognition.

CHAPTER 3

OBJECTIVES

Augmentation has the potential to improve our health, entertainment, productivity, and overall quality of life. It aims to break through the biological boundaries of the human body. A common definition of human augmentation is "technologies that enhance human productivity or capability, or that somehow add to the human body".

Motivation:

Human augmentation aims in replacing or enhance human abilities directly, not through an external tool that is manipulated through an interface so that the user feels comfortable in using it. It aims to make human life safer while operating in a hazardous environment with ease.

Scope:

- Human augmentation provides wearable technologies
- Enables users efficiently and effectively
- Helps in better control and monitoring of an environment.
- Minimize the load on the user

CHAPTER 4

LITERATURE SURVEY

[1] R. Huang, H. Cheng, Q. Chen, H. Tran and X. Lin, 2015, "Interactive learning for sensitivity factors of a human-powered augmentation lower exoskeleton,"

Sensitivity Amplification Control (SAC) algorithm was first proposed in the augmentation applications of Berkeley Lower Extremity Exoskeleton (BLEEX). The SAC algorithm is widely used in human augmentation applications since it just need the information from the exoskeleton robot, so that the complexity of exoskeleton system can be reduced greatly. However, the SAC algorithm has two main drawbacks: 1) requiring accurate dynamic models of the exoskeleton, 2) can not manage the variation of interaction dynamics from different walking speed. This paper presents a novel developed learning control strategy based on SAC algorithm. In the proposed Adaptive Sensitivity Amplification Control (ASAC) strategy, the reinforcement learning method is utilized to learn the sensitivity factors online for the sake of handling the variation of interaction dynamics. The paper demonstrates the control efficiency of ASAC on an one degree-of-freedom (DOF) platform with swing movements first, and then extend it into a human1powered Augmentation Lower EXoskeleton (HUALEX). The experimental results show that the proposed ASAC strategy can handle the changing interaction dynamics with less interaction force between the pilot and the exoskeleton as compared with traditional SAC algorithm.

[2] T. Kymäläinen, 2016,"Introduction to the Special Session: Design and Research for Advanced Human Augmentation,"

In [2], special session has called for contributions that demonstrate research in advanced human augmentation. The introduction briefly describes how the concept is currently understood, and, in the creative science spirit, depicts how it may be understood in the more distant future. To explain this, the introduction presents a short science fiction prototype that illustrates how future co-creative intelligence will combine human technology with human intelligence by emphasizing the role of human centricity in the advanced human augmentation vision. To achieve an overview of how the vision is currently being pursued, this special session demonstrates contemporary research that advances the ideas. In the session the nominated contribution is limited to the industrial work context, training and mentoring, and assistive augmentation for the elderly and visually impaired. The technological focus is mainly on virtual/mixed/augmented realities, eye-tracking systems and head-mounted displays.

[3] K. Kunze, K. Minamizawa, S. Lukosch, M. Inami and J. Rekimoto, (2017) "Superhuman Sports: Applying Human Augmentation to Physical Exercise,"

In [3], Science in particular, information technology is already an integral part of today’s sports training and events. However, traditional sports emphasize the achievements of the individual. Sport federations and competitions struggle when it comes to knowing how to deal with the augmented human concept. In contrast, superhuman sports aim to create a field where people compete, overcoming technological rather than solely human limitations. The focus is on improving cognitive and physical functions of the human body, creating artificial senses and reflexes to participate in sports competitions. Augmenting the body is the most straightforward notion. The goal is to enhance a sports practitioner’s inherent abilities using wearable technologies and implantables. Augmenting the playing field aims to make the sports more interesting and enjoyable to play—for example, using projection technologies to indicate where a play ball might go or converting part of a sports field into a virtual ocean. Augmented training deploys information technology to improve training and enhance the inherent capabilities of professional and amateur sports practitioners—for example, using electric muscle stimulation to build up specific muscle regions or transcranial direct current stimulation to improve hand1eye coordination or other motor tasks.

[4] N. Oertelt et al., (2017) "Human by Design: An Ethical Framework for Human Augmentation,"

The Ethical Framework for Human Augmentation that is presented here is a tool for navigating ethical questions that emerge around human augmentation. It is designed to be inclusive of the wide community of stakeholders within fields that touch upon human augmentation technology — medical professionals, the DIY community, corporate interests, legislators, and those in the military. This tool may provide a framework for doctors to act upon medical interventions requested by an individual for the purposes of enhancing a bodily function or creating a new set of abilities. It can guide inventors in deciding to abandon or pursue certain research areas that may have far-reaching implications. It can guide manufacturers towards transparency or increased access to users of licensed hardware and software. It can help guide patients in deciding what they can reasonably request of medical professionals and manufacturers. It could guide legislators in the process of writing laws around the use of certain forms of technology. It might guide regulators in deciding whether to approve or reject a proposed technology for public or private use. Importantly, this ethical framework is designed to help foster democratic forms of deliberation for different groups of people that have a stake in the future of the lived human experience. The paper provides ethical frameworks presented in multiple documents, including New Directions: Ethics of Synthetic Biology and Emerging Technologies and Bioethics for Every Generation: Deliberation and Education in Health, Science,

[5] K. Shang, X. Xu and H. Su, 2017, "Design and evaluation of an upper extremity wearable robot with payload balancing for human augmentation,"

Electric, pneumatic and hydraulic tools are widely used in industry. Repetitive tasks using heavy tools would often cause fatigue for workers leading to musculoskeletal injuries. The efficiency and manufacturing quality can hardly be guaranteed either. Powered exoskeletons for upper limb and lower limb assistance have been developed recently. To augment human capability of upper extremity without energy consumption and laborious maintenance, a passive gravity load-balancing mechanical arm is designed to unload the workers from the weight of heavy tools using the principle of the torque balance. The authors have created a mechanical arm. The mechanical arm is composed of two independent gravity load balancing arms and a connection mechanism. The distal end of the mechanical arm is connected to the mechanism that carries the tool, and the proximal end of the mechanical arm is mounted to a base support. The weight of the tool is transferred to the ground through the mechanical arm and support, so the operator does not bear its weight. In the mechanical arm, the gravity load balancing arm ensures that the mechanical arm well balances the gravity load in real time in the vertical motion. The hinge of the gravity load balancing arm allows the mechanical arm to move freely in the horizontal plane. The experimental result demonstrates that the proposed passive mechanism can effectively counterbalance the tool gravity. Future study will investigate its biomechanical and physiological outcome using motion and EMG sensors.

[6] R. Tommy, H. Jose and M. Reghunath, 2017, "Augmentation of Things,"

Augmented reality and Internet of things are two emerging technologies. The Intersection of both would be an engrossing area. If the visual and location based features of augmented reality is combined with real objects which could be operated via internet of things the impact would be great in enhancing user experience. The author’s researches Augmentation of Things aims in integrating the visual impact of augmented reality with the actionable information from Internet of Things providing a location enabled smart system which will create an unparalleled experience for the user.

[7] H. Kim, M. Y. Kim, S. Yang, K. Kim, H. Son and Y. Lee, 2017, "Smart wearable robot glasses for human visual augmentation based on human intention and scene understanding,"

The paper focuses on the design and implementation of smart wearable robot glasses for human visual augmentation, which take a role to provide the refined visual recognition result to users of wearing the proposed system. The proposed system consists of a glass-type wearable device with a front looking camera, an eye looking camera, and an earphone, and signal processing units. The scene-analyzing process on the input image acquired by the front view camera is supported by an eye view camera of monitoring the eye position of user for efficient information processing, which is used to catch the user's visual intention and attention in given situations. The recognized results are transformed into the audio information for the user friendly information service without obstructing the users' own visual information gathering and processing, and then the result is transferred into the user earphone finally. This device can be used for the augmentation of human visual capability in various areas, museum, conference, meetings, etc. For the proposed device's feasibility, a series of experiments are performed, and the evaluation results are discussed in detail.

[8] S. Leigh, H. Agrawal and P. Maes, 2018, "Robotic Symbionts: Interweaving Human and Machine Actions,"

The article defines a category of human-robot interaction in which human and robotic actors work as a single unified system. Authors conduct survey work from various fields including human augmentation systems such as extra fingers and arms, and other robots that operate in close proximity to the user. The discussed works highlight a close interplay between human and robotic actions where control decisions are made by both actors. Such a dyadic configuration can yield a synergistic outcome but require that close attention be paid to the coordination between them. Using case studies from experimentation, the paper discuss two main questions that must be addressed when designing such closely collaborative human-robot integrations: type of support and degree of control. The different choices that can be adopted for each of these design questions define a framework or classification that is useful for surveying existing and future research.

[9] N. Davies, M. Langheinrich, P. Maes and J. Rekimoto, 2018 "Augmenting Humans,"

In [9], The three articles in this special section address the use of computing services and technologies to augment human activities. Technology has long been used to augment our physical and cognitive abilities. Heavy machinery enables us to lift objects well beyond our strength, reading glasses correct and enhance our vision, and cameras capture memories for future recall. Wearable computing pioneered the integration of technology into our clothing and even our bodies, but ambient computing systems are also increasingly capable of supporting cognitive operations: a projected user interface, for example, can improve our sense of direction or ability to assemble a complex machine. Next-generation systems promise to augment our senses, voices, motor activities, and even our minds in unprecedented ways.

[10] G. Weinberg, 2019,"Robotic Musicianship and Musical Human Augmentation"

Robotic Musicianship research at Georgia Tech Center for Music Technology (GTCMT) focuses on the construction of autonomous and wearable robots that can analyse, reason, and generate music. The goal of the research is to facilitate meaningful and inspiring musical interactions between humans and artificially creative machines. The paper present the work conducted by the Robotic Musicianship Group at GTCMT over the last 15 years, highlighting the motivation, research questions, platforms, methods, and underlining guidelines for our work.

CHAPTER 5

METHODOLOGY

The present model for wearable augmentation: augmenting human senses, action and cognition through wearable technology. The starting point is that the technology will enhance human abilities directly, not through an external tool that is manipulated through an interface. Interaction should be as close to actual human action as possible, which leads to a need for tracking human activities used as inputs for the augmentation system.

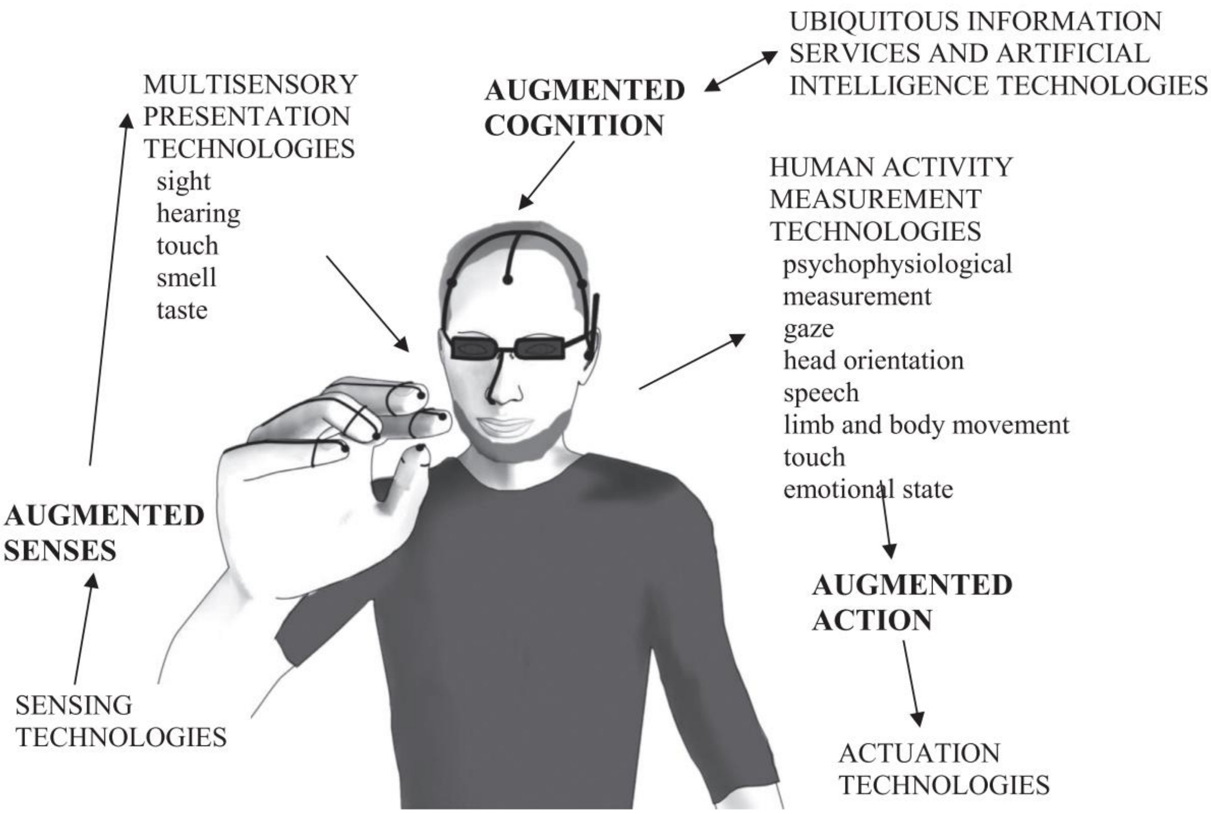

Figure 5.1 Information flow and related technologies in wearable augmentation

The proposed enabling technologies for wearable augmentation are as follows:

- **Sensing technologies** detect the environment, objects, and events. These include pattern recognition and other computer vision methods, auditory sensors, spatial, thermal and movement sensors, multispectral cameras, and touch, olfactory and gustatory sensors.

- **Multisensory presentation technologies** support attention, memory, and perception; it is achieved through light-weight multimodal mixed reality glasses, crossmodal information presentation, and wearable accessories. It applies different human senses: sight, hearing, touch, olfaction, gustation as channels to mediate augmented sensing and feedback on augmented actions.

- **Human activity measurement technologies** are based on different wearable sensors. Human activities are recognized as inputs through, for example, speech recognition, motor activity tracking, eye tracking, and force and touch input. Based on this low-level information, human activities are modeled at a higher level.

- **Actuation technologies** are used to affect the environment as directed by the human. These include different kinds of visual dis1plays, audio equipment, haptic actuators as well as smell and taste generators. In immersive environments, also the sense of balance may be affected through the generation of forces and human pose.

- **Ubiquitous information services and artificial intelligence** technologies will provide access to networked information services, internet of things and artificial intelligence support. This will enable to develop personalized AI extensions that can assist and autonomously support a variety of tasks that users are unable or unwilling to perform.

Augmented human is a new user interface paradigm, which merges and expands many of the old paradigms. Our model for wearable augmentation alters the real world beyond augmented interaction. Numerous sensors and cloud data provide information, artificial intelligence filters it and it is presented in easy-to-understand ways to support human cognition in a timely manner. Physical tools or robots enable action in and changes to the environment. It should be noted that human augmentation does not mean focusing on individualism. Actually, augmented humans may be better aware of each other and have a close connection approaching to something that feels like a direct brain connection. At its best, other people are brought close to us, independent of where they are physically located. At its worst, privacy and autonomy may be threatened.

CHAPTER 6

HA APPLICATION IN VARIOUS FIELD

1. Visualization

Visualization can be one of the most powerful tools that can be use to augment human capabilities. A picture is worth a thousand words, and visualisation encourages you to find insights in ways that data alone cannot.

2. Sensory Augmentation

In everyday business, there are many examples of sensory augmentation such as using machine learning to enhance radiologists' abilities to do more accurate x-ray diagnoses or enhancing the ability to back out of the obstacle by sensing the garbage cans that are blocking in vehicles!

3. Brain-Computer Interfaces

Brain-computer interfaces are the means of using technology to directly communicate with other human body parts. For now, it is being used to treat paralysis and to help patients gain mobility. In the future, however, BCI-users can connect their bodies directly to the internet or other services, changing the worldview and how it functions in the digital era.

4. Natural Language Generation

Human augmentation tech has come a long way, even creating hybrid environments where man and machine work together. This is true in the Natural Language Generation (NLG) sector, where tools like Phrasee help marketers find the right words and bring objectiveness into writing through automation. This essentially augments a copywriter's natural abilities through the power of NLG.

5. Exoskeletons for Workplace Safety

Exoskeletons are exciting technology and how they will keep workers safer in environments that require heavy lifting and loading. With exoskeletons, freight loaders and maintenance workers could lift heavier loads of up to 200 lbs., without fatigue or strain. Emerging technologies like these ensure higher levels of workplace health and safety, as well as the empowerment of workers to be twice as productive.

6. Neurally-Controlled Artificial Limbs

Taking an idea from movies and literature, the excitement about the integration of the brain, computers and artificial limbs. How technology companies around the world create prototypes to help patients gain more intuitive control over their arm or leg prosthetics. The collaboration between pure research institutes like DARPA and leading tech companies is fascinating.

7. Superhuman Sensory Enhancement

The world is starting to see a turning point in AI augmentation that can enhance the senses in a way envisioned in books and movies. That turning point is in human-centred AI that augments our senses to superhuman capacities. Whether it be increased vision, decision-making on the battlefield or resource support in times of pandemics, AI with the human in the centre is revolutionary.

8. CRISPR

CRISPR is a technology that has the power, simplicity and flexibility to edit genomes in an amazingly fast time, which can lead to augmentations in humans. This biotechnology has the ability to modify the genome, making it an extremely powerful human augmentation technology. When it is perfected, its use will be unparalleled.

CHAPTER 7

BENEFITS OF HA

Human augmentation or enhancement technology has impacted human life for good. First, task automation might in some cases increase the effectiveness of the human, rather than removing him or her. Much of the advance in car design, for instance, makes the human a better driver (warning lights, auto braking, cruise control). Some of this is related to comparable efforts for pilots, where the explicit goal has been to make the pilot better, rather than removing him or her from the cockpit. The task might be redesigned to take advantage of human augmentation, as is done now to enable people without legs to drive or ride a bicycle.

Second, human augmentation will help with adaptations forced by task automation. Boeing, for instance, has some of its mechanics wear special headgear that annotates what they see to help them assemble planes. This headgear not only constitutes a design for using humans better, it also expands the range of humans who can perform the task, since new mechanics need not undergo hours of training to know what the special headgear shows them. While special headgear is unlikely to enable lumberjacks to write computer code, it may well enable them to fit into many roles that would otherwise take years of retraining.

In addition to enhancing the overall quality of human life, it also serves with following benefits:

- Support or improve human capabilities and performance
- Alleviate social inequalities
- Mitigate social inequalities
- Improvement of overall physical and mental health
- Ensure human well-being
- Enhance bodily integrity

CHAPTER 8

CHALLENGES WITH HA

Human enhancement or augmentation can be understood as an individual choice creating value for the user. This does not exclude raised concerns related to the effects of human augmentation to individuals and society in general. Already now when human augmentation is taking its first steps, users have valid practical concerns related to the new human augmentation technologies that can weigh more than personal experiences and benefits. Overall, human augmentation is a leap to the unknown, and neglecting potential negative effects of such technologies to daily life and society can create undesirable scenarios for the future. There will surely be many unintended consequences. In the following section, there are practical concerns related to individual rights and concerns as well as scenarios related to potential threats to society. Finally, some solutions are offered to solve these complex problems.

8.1. Problems related to individual users

8.1.1. Privacy

The novel human augmentation technologies are often being developed by large organizations. This means that collecting enormous amounts of data from the users, advertising, promoting interest of the organization, and getting profit from them has effects on the ethics in this field. As the interaction technologies become more and more pervasive and at some point even invasive, the ownership of the collected data, access by third parties to the data, and regulation of the content creation becomes a significant issue. For example, augmented cognition enables the collection of information from the brain which violates privacy in unimaginable way compared to the current technologies. . It is easy to envision how systems that log and analyse events, people, and places using text, audio and visual material create a situation in which access to such sensitive data and controlling it can be harmful to individuals. This is especially true if there is no possibility to erase the logged data.

8.1.2. Social manipulation

As augmented technologies are by nature very pervasive, it can be extremely difficult to distinguish between real and unreal events, and thus subtle manipulation can be impossible to detect and suppress. The augmented sensing technologies may easily be programmed to contain erroneous information. Even more invasive brain-computer interfaces and other neurotechnology applications can overcome sensory stimulation and thus create a potential for manipulation. Already the con1temporary artificial intelligence techniques can be used to create fabricated visual and auditory information, which endangers information credibility. Since augmented sensory experiences can be created, for example, by a large company, the creator of the technology has the power to control what the user sees or hears. Even though this may seem like an irrelevant concern, it offers the potential for manipulating the user through life1like augmented and pervasive sensory experiences.

8.1.3. Autonomy and side effects

In respect to autonomy, a common threat is a situation related to sensory overload, in which information is no longer efficiently processed. There are also concerns related to patient autonomy and responsibility in case of an accident when technologies are utilized, for instance, by patients suffering from neurode generative diseases. The most complex ethical concerns arise from augmented cognition. Especially neurotechnological implants and chemical stimulants can be extremely harmful to the user through side effects, or to the society in terms of creating a potential for terrorism.

8.1.4. Accessibility

Universal access is a serious problem when technologies capable of exceeding the natural abilities of humans are being developed. Most often, the reason behind the inclusion of the novel technologies is simply the cost. However, technologies can be inaccessible for special user groups like hearing impaired or elderly. Augmented senses, in general, can be seen mostly as creating positive impacts for the people in need of sensory assistance. However, the group benefitting the most from the augmented senses is very diverse. While in the other end of the continuum are young millennials who can suffer from, for example, hearing problems but use technological devices and assistance seamlessly, other groups like hearing impaired elderly can suffer from problems even while using simple smartphone applications. For the elderly, the potential of novel technologies easily creates a conflict between an actual need and the combination of in1dependence, dignity and privacy. Augmented action can bring out somewhat similar concerns as augmented senses. Again, the diversity of people benefitting the most from the technologies can create unbearable challenges for the designers. Universal access is the most studied societal issue in the field of augmented technologies. For example, using enhancement technologies to increase one's abilities while excluding some groups outside similar benefits can threaten equality in society.

8.2. Societal concerns

8.2.1. Safety and balance

The new technologies used for social control are not a big problem under benevolent government, as they are also beneficial (to root out terrorism, to immediately call an ambulance when needed, etc.), but they may become a Pandora's box. Perhaps also the good societies will degenerate to right-wing, left-wing or green fascism after the next major recession or war. It is not necessarily only the governments which try to control their subservient. A similarly grim vision would be that social media and ICT giants could try to influence elections, laws, policies, buying habits or worldviews, or by grabbing selected fields of power from governments. However, the big tech companies and governments are not competitors but rather collaborators, because they have many vested interests.

8.2.2. Unpredictable future

Augmented action, sensing and artificial intelligence are known to be able to reduce the need for human labor force meaning that a large amount of population could face unemployment. The effect will be the largest with people working with routine tasks, and not so surprisingly, uneducated workers are already worried about their future. Overall, it seems that technology can increase the disparity in working life. On the other hand, mankind has gone through quite many disruptive technologies such as steam engines, electricity, industrialization, tractors, cars, atomic power and automation, and as a result, our world are now better off than ever. The digital divide in population and other related issues are rather complex. The potential effects are quite serious issues and should not be overlooked when adapting novel technologies in workplaces or in our personal lives.

In augmented action, ethical concerns are closely related to interaction design . The rules how to act in shared, virtual, or augmented realities by using augmented motoric movement and action are in the hotspot of successful ethical implementation of this field of research. What can the users, avatars and robots do? How can they manipulate their surroundings? Are they capable, for example, to violence?

Augmented cognition is creating a situation in which mankind is taking a giant leap forward. In the scope of this article, it needs to be understood that human cognition, as well as brain functions or artificial neural networks mimicking and helping cognition, are not fully understood. The following example can be used to illustrate the point. EEG measures brain activity and an AI algorithm analyses the data to make interpretations of the user's state. However, EEG activity can be a result of various cognitive processes. In addition, AI methods have their limitations, and when large amounts of data are being processed, it can be impossible to understand why the AI method makes a particular prediction. Without taking these restrictions seriously, the users lose the ability to plan the potential effects augmented cognition can have on individuals and society. Overall, it seems that in this field, public policies and regulation will be needed.

8.3. Solutions to mitigate ethical problems

All the ethical issues raised in the field of human-technology interaction can mostly be overcome by creating international guidelines, standards and laws for ensuring privacy, safety, equality and better design for user interfaces. Inclusive HCI design approach can also offer some solutions to the problem. For ex1ample, the need to control personal data privacy is already acknowledged in the European Union's General Data Protection Regulation (GDPR). Similarly, it can be noted that social inequality issues were a concern when smartphones were introduced, but nowadays also the poor use them and benefit from the technology.

By stretching human abilities beyond their natural limits, it is possible to fundamentally change society for better or worse. History shows that any technology can and will be used for both good and bad. By considering ethical questions before implementing new technical solutions to augment humans, one can envision how to use them to create a better and more equal future for us all.

CHAPTER 9

FUTURE OF HA

The concept of human augmentation, which is also called human performance enhancement or HPE, tends not to receive much attention because it is diffuse. It encompasses a range of technologies across very different disciplines. It's helpful to gather them together under one heading and survey the different ways in which humans might potentially alter our own nature.

There are five main areas where human augmentation is still being pursued.

1. Bionics and Prosthetics

This is the form of human augmentation that is already being tested out for a small number of special users. People can even go to a Cyborg Olympics, a competition to test whose bionic limbs and robotics exoskeletons are the best. The ultimate goal for military applications is an armoured robotic super-suit. One of the biggest challenges is to coordinate our bionic or robotic augmentations with the brain to send signals back and forth across the barrier between our mechanical enhancements and our biological nervous system—so that the user will be able to pilot a robotic exoskeleton with the same ease with which move one of their own limbs.

2. Brain-Computer Interfaces

The aim is to have faster, seamless access to information and to interaction with our machines. The query is will this result in an even greater dependence on our devices? Could it lead to a real life version of a cartoon? These enhancements aren't ready yet, but a lot of capital is being poured into them. Elon Musk just announced the launch of Neuralink which is working on a "neural lace" brain machine interface. He joins another Silicon Valley entrepreneur, Bryan Johnson, whose Kernel start-up is working on the same problem. But Kernel isn't just trying to make neural interfaces for our machines. It's also experimenting with ways to change and enhance the functioning of our brains. That's an even more radical notion and leads us to the next form of future human enhancement.

3. Neurotechnology

The aim in building enhanced mental function, possibly even some form of super-intelligence, into our own brains instead of building it into a separate computer. However, what are the side-effects and potential long-term consequences of altering our brain functions with implants? Consider one of the reasons steroids are banned in most sports. When one player begins taking steroids, this can enhance his performance so dramatically that everyone else feels the need to take them to remain competitive but then everyone ends up experiencing the side effects, both immediately and in the long term. So one reason for banning steroids is to keep athletes from ruining their bodies in an attempt to keep up with their enhanced rivals. Speaking of steroids, that brings us to our next form of enhancement. Using electronic implants to affect our brain functions is a radical and difficult step. Instead, could just try doing it the old-fashioned way: with pharmaceuticals.

4. Nootropics

The aim is to create Super-smarts, like a pill(which is, in fact, based on a real drug). The problem: "long-term safety studies in healthy people have never been done. Most efficacy studies have only been short-term." What the user tend to get is a lot of anecdotal evidence from committed enthusiasts, but it is hard to tell how much of this is just a placebo affect among people who would be motivated high achievers in any case.

5. Gene Editing

The researchers are trying to pick and choose extraordinary abilities out the gene pool and putting them all together in ultra-capable new humans. However, There is the risk that in re-engineering our own DNA, the user will introduce problems instead of improvements, and that won't be known this ahead of time. A normal, healthy person might be inclined to leave well enough alone rather than signing up as the guinea pig for an untested enhancement, but there are two circumstances where the incentives become much greater and the inhibitions lower. First, there various forms of augmentation being tested on those who are injured, diseased, or disabled, where the purpose is not to enhance their performance, but to bring them back to normal. It's a matter of risk versus reward. Second, the main driver for the use of such enhancements will probably be its military application. It's a similar risk-reward.

Moreover, the next stage of human development is likely to come slowly and gradually, over a period of many decades. Boosters of the new technology may predict that they're going to be downloading their minds into computers. If that ever does happen, it will almost certainly take much longer. This means a person will have time to adjust, and in the meantime, they will enjoy so many other technological improvements and minor enhancements that what seems dangerous and unnatural today may not seem so radical by the time it actually becomes available.

CHAPTER 10

CONCLUSION

Human beings have always been striving to improve their natural abilities. This need to evolve has shaped human development and what it means to be human. However, gradual natural evolution may soon take a backseat as human beings take control of their own future. The need to be stronger, faster, and smarter has contributed to a vast number of scientific developments. A large number of technologies from gene therapy to exoskeleton attachments and from brain-computer interfaces to having the entire global repository of information at one's fingertips can soon enhance and alter our abilities. Some of these technologies are still in their infancy and need to mature over time. However, many technologies can already be integrated to augment core human abilities.

There are many benefits to the user enabling human augmentation such as replacing a worn-out ability and extending ones capabilities. At the moment, most of these technologies are used independently with little to no fusion. Creating an integrated, intelligent wearable system is the next essential step in the progression of augmenting human abilities. The once diversified technologies with variable use cases are now coalescing into a robust framework that lays the foundation for the Augmented Human of the future. This advancement will revolutionize the meaning of being human. However, due to ethical issues related to such augmentation, regulation as well as international standards and guidelines are essential for ensuring privacy, universal access, etc. to such technologies.

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