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Human-Machine Integration as Support Relation: Individual and Task-related Hybrid Systems in Industrial Production and Elderly Care – Approach, Development Procedure and Exemplary Technical Systems

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1 Extended Abstract

The design of interactions between humans and technology – especially with regard to demographic change as well as the more frequent and much more intense relationship of human and technology in many areas of life – is one of the greatest societal challenges right now. Despite the many existing approaches to Human-Machine-Interaction there are still open questions. Many of the relevant issues can be tackled, however, when any design of such relationships conceives of these interactions as relations of support. That is, humans and technology are both designed out of their joint operation in support situations. This sounds odd but it is crucial to acknowledge that both sides are affected when their relation is targeted in the course of technology development. Both do not traverse the interaction unchanged. The human in the loop is not simply the same as the human being dwelling outside such socio-technical arrangements.

Technology is already supporting people in many areas of life. Health prevention is a particularly important domain in this respect. Regarding issues of musculoskeletal disorder/stress (MSE) in an ageing work force, it is common to look at technology for some remedy. Relevant assistive technology will come in different forms and, in broader terms, as different technological artefacts, who reveal their potential in conjunction with its human users and the environment in which they are embedded. They can be substantially characterized in the light of their abilities to support physical or cognitive human tasks. Depending on the task at hand, technical assistive devices and/or robots might take over the activities completely, thus acting oftentimes in a different temporal-spatial field as their human counterparts.

However, these (semi-) automated solutions are often only technically feasible or

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economically viable for simple and repetitive tasks. Consequently, there are numerous tasks in the world of work and in private environments which still have to be carried out manually because of their complexity or uniqueness. In these areas, where assistive technology acts in close proximity and in collaboration with its user, e.g. in pushing-pulling or lifting tasks, technology and human beings can be seen as a single entity. This is one step further than simply looking for the design of their interaction. Therefore, the decisive challenge in development of these technologies, is not merely the development or the invention of new technology in itself, but a prognostic view of how future technology and humans might interact/integrate and what implications such newly "integrated entities" should have on strategic technology development. The relation between human and technology is not a zero-sum game. More technology does not necessarily mean less human abilities or even outright substitution of the human work force. Unless this becomes clear, the potential of hybrid systems will always be prematurely criticized and thus consistently underestimated.

By designing the timing, coupling, and mutual control of the cognitive abilities and sensorimotor skills of humans on the one hand in immediate connection with the reliability, speed, and force of technical artefacts on the other, we get hybrid embedded systems, deployed in responsible ways with a potential to improve human health. New and promising approaches of technical support include body-related or wearable technical systems, e.g. classic exoskeletons for increasing power or systems for force redirection and support of cognitive structures.

This contribution examines approaches and solutions for the support of ergonomically strenuous or quality critical manual tasks, e.g. in automotive, aircraft, and industry. Based on task dependent requirements and the approach of Human Hybrid Robot (including a construction kit systematic) different context-adapted solutions are described. These include wearable systems for tasks at or above head level with handling of tools or components as well as stationary systems for supporting quality-critical tasks in form of manual workstations. Moreover, the development of such user centered systems requires a participatory approach in order to increase the probability of acceptance and usability. Therefore, we will also describe some critical steps for facilitating this form of technology development. The most essential part in developing systems that are worn just like clothes, is user integration to the development process. Physical interaction reaches a level not seen before in the development of technology. Success is achieved when the user feels comfortable with the system. This necessitates a proper design of hardware to give the user the necessary freedom of movement and accompanying software to know or detect what the user wants and make the system act accordingly. For both aspects of the development process, there is currently little knowledge in to what the user wants and there are many dependencies between the capabilities of different hardware and software modules, making it harder to develop components independently. Therefore it is necessary to create frequent minimum viable prototypes, which present the potential user with a satisfactory user experience. It is very difficult to obtain feedback from the user for specific features of hybrid (exoskeletal) systems, as deficits in some areas (especially comfort) will overshadow every other aspect. In order to overcome this challenge a rapid prototyping workflow (3D-printing, prebuilt mechatronic assemblies etc.) are indispensable in order to generate satisfactory prototypes in a viable timeframe and to get meaningful user feedback.