Mechatronic systems for aided gait – interactions with the environment

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1. Introduction

Mechatronic devices and systems, whose microprocessor unit replaces man in making decisions as far as standard situations are concerned, constitute nowadays a group of technological products that leads in most of the fields connected both with manufacturing as well as everyday life of man [1,2]. They are also a big chance for improving comfort of existence of the people afflicted with severe illnesses. Besides important applications of mechatronics while building a medical aiding equipment, or even an equipment enabling a treatment of an injured man, there occurs a chance for relieving results of the diseases in situations, when computing power of microcontrollers and dynamics of measuring and regulating systems allows the motor activities of humans to be replaced with technological devices. An awareness of still broadening technological possibilities within this range caused employees of the Division of Design of Precision Devices, Faculty of Mechatronics, Warsaw University of Technology, to propose designing a device for assuming erect position as well as aiding gait in the case of individuals suffering from paraparesis. Problems pertaining to such devices are at present dealt with in leading research institutes worldwide. There already exist practical effects of these works, being almost ready to be implemented.

2. The Device for Aided Gait

The aim of the works is to elaborate and build original technological models of a VENI device for moving in erect position, dedicated for persons suffering from paraparesis, according to the latest trends related to the field of bionics. The statistical analyses that have been carried out indicate that a population of handicapped persons in Poland is of ca. 5.5 million people, including ca. 1 million with biological limitations and 4.5 million with a disablement as defined in the law. Within this group an employment factor have not exceeded in recent years 15% in relation to over 55% within the group of healthy people [3]. In the proposed solution, a handicapped person can move thanks to application of a mechanical system attached to its inactive lower limbs, substituting their function by means of a forced movement reflecting comprehensively natural movements of the legs (Fig. 1).

Fig. 1 Concept art of VENI – a mechatronic system for aided gait.

The device is foreseen to be a complicated mechatronic system. Its essential function will be an aided gait of the user and its auxiliary functions will be ensuring safety of the gait, inspection and diagnostics of the regulating systems, informing the user about a state of the device and the procedures being realized. Realization of these tasks requires an interaction of the system with various elements of its environment (Fig. 2).
3. The Environment of the Device

Specificity of the device being designed, as well as an assumption that it will be used by persons who are subjected to certain limitations of physical movement (i.e. paraparesis), forces acceptance of a certain way of designing, which must be oriented at the needs of the user, who is the most important element of the operating environment, so it should be an ergonomic designing. Because of the need of adapting to the needs of an individual user, instructions that pertain to designing a device with regard to the needs of only 90% or 95% of the population should be rejected. That results both from humanitarian aspects and limited anthropometric data referring to persons who are subjected to limitations of movement of the lower limbs. The fist and basic aspect is to adjust algorithms of motion of the device to motor abilities and anatomy of the user. It seems rational to assume a modular structure of the device. This type of solutions are already applied in modern prostheses, what is significant, since the device and the accepted philosophy of building it, servicing and operating should conform to the latest trends in aiding persons with limitations of the physical movement.

At the same time, the design and operation of the device will be conditioned by components of the social, legal and technological environment as well as operational environment. The initial studies carried out [3] indicate a high, over 90%, level of positive public response to using by the handicapped devices aiding motion. At the same time, a quite considerable feeling of a lack of contact and alienation of the handicapped exists in the society [3]. Parallel to elaboration of the concept and the VENI project, there comes also a development of a concept of the infrastructure that accompanies it. Besides the regulations that exist at present, pertaining to the architectural barriers, it will be necessary to adjust facilities of the public and individual transportation.

4. Conclusions

The device for aided gait being designed for the handicapped should be a considerable contribution and a new solution, enabling the handicapped to take an active part in social and professional life. However, a success in introducing the system to usage will be dependent also on some factors out of the technological domain. An appropriate development of the infrastructure will be significant, making it possible at least to load batteries of the device. It will be important to develop and adjust the legal environment, regulating matters of safety and responsibility connected with appearance of a new category of traffic participant.

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References