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MINIATURE ROBOT WITH APPLICATIONS IN BIOMEDICAL ENGINEERING

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Abstract: Rehabilitation engineering - an interdisciplinary branch of biomedical engineering, is the application of science and technology to compensate the handicaps of individuals with disabilities. Its role is to determine a more effective rehabilitation process. The most dynamic component of rehabilitation engineering is rehabilitation robotics. In this paper the specific features of robotic systems for people with a wide range of disabilities are presented. A 2 DOF miniature robotic system designed in order to assist disabled people during eating is proposed. Its structure and operation are described.

1. THE REHABILITATION ROBOTICS

The activities specific to engineering are more and more involved in increasing the quality of life in general, and the efficiency of medical services, in particular. At present, a new field of engineering may be taken into consideration, called biomedical engineering, which has as main concerns the study, the project development, manufacturing and use of materials, devices, apparatus and techniques for the prevention of different disorders or for diagnosing and treating patients, [2]. The activities in this area are diverse, covering both the field of non-experimental theories, and that of practical applications. They consist of research activities, project developing, manufacturing and exploitation that refers to: Biomechanics, Biomaterials, Biosensors, Biomedical Instrumentation, Medical Information Technology, Medical Imaging, Biotechnology, Clinical Engineering etc.

The Rehabilitation is a form of complex, unitary medical and social assistance that takes place in a continuous manner and has as a purpose the reintegration in the society and in the family of people who suffer from different deficiencies, [13]. The main principle of the rehabilitation assumes the evaluation of the remaining functions, of the anatomical integrity and of the psychological state (the so called morpho-functional and psychological remainder of the patient). It is quantified, maintained and developed. Among the attributes of an efficient rehabilitation activity we may find the technical support of the rehabilitation team.

The most significant fields of activity of the rehabilitation engineering are: The equipment of assistance or replacement of the motor and sensorial functions, specially prosthetics, equipment for insuring the postural stability, wheel chairs for the handicapped persons, equipment for mobility restoration and for transportation, the analysis and the assistance of walking, the assistance of the communication functions, ergonomics and measuring of human performances, modifications and adaptations of the environment. ***Rehabilitation Robotics*** is the newest and most dynamic field of rehabilitation engineering. It consists of the total of robotic systems, of a great constructive and functional variety, conceived for a faster and more efficient rehabilitation process.

By principle, the rehabilitation robots are:

a) mobile robots – robotic systems mounted on o mobile unit; they are controlled directly by the user, or are (semi)autonomous (have the ability of moving from a location to

another by using an algorithm of avoiding obstacles). They are designed, specially, for use in homes, but can also be employed in rehabilitation facilities and hospitals.

b) stationary robots – robotic arms mounted on platforms attached to the working table or to the bed of the user, arms that can manipulate tools and table linens etc. and / or to interact with a PC. In this case, the robotic systems work in an organized environment because the objects have a well determined position and memorized. They are independent units, that can be mounted in rehabilitation facilities.

According to the rehabilitation procedure, there exist the following types of rehabilitation robots, [3], [6], [15]: *the robotic systems attached to the wheel chairs for the handicapped persons or to a bed (manipulating arms), autonomous wheel chairs for people with handicaps, mobile robotic systems for the assistance of people with disabilities robotic systems for the assistance of walking and maintaining the bipeds posture, robotic systems for effecting rehabilitation exercises, robotic systems for measuring biomechanical parameters and evaluation of performances, prosthetic / orthotic robotic systems.*

Among the strategies of the companies, we may find the following two characteristics: the development of unique products, adapted to the user and the understanding of the functional limitations of the potential users. The main difficulties specific to the rehabilitation robotics are determined by: the necessity of designing new functional and constructive solutions or the adaptation of the known solutions to the individual requirements of each patient; limited funding and time for realizing a product; great difference between the technical and technological possibilities and the requirements of the patients.

2. THE DESCRIPTION OF THE DESIGNED SOLUTION

In this paragraph is presented the contribution of the authors in the field of robotic systems designed for the assistance of people with disabilities during the feeding process.

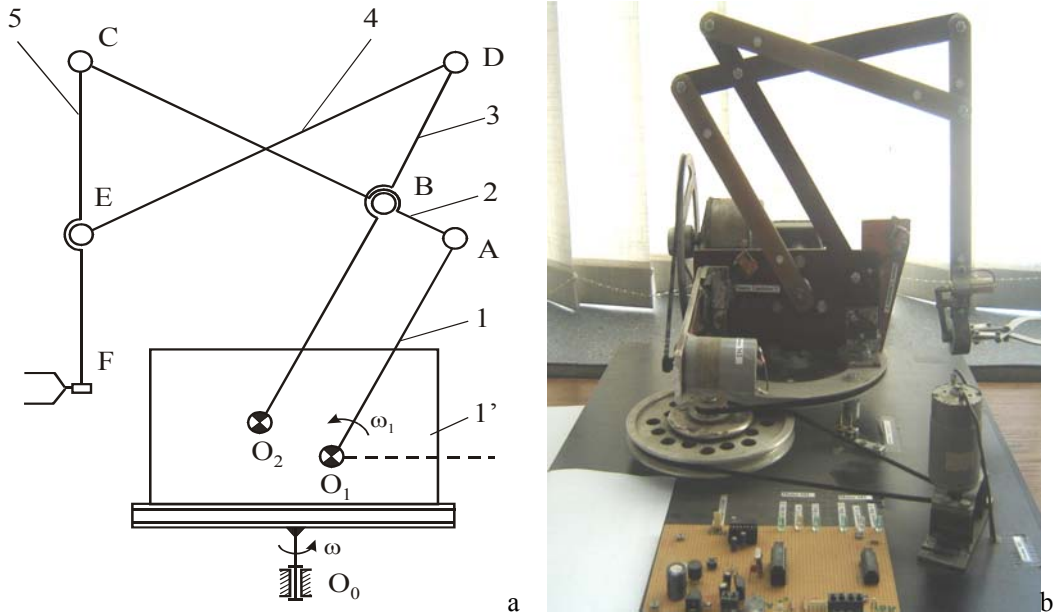

Fig. 1 The structure and the photograph of the minirobot

The proposed system has two degrees of mobility. In figure 1a is shown the structural schematics and in 1b is a photograph of the realized prototype for performing certain experimental work [15].

The minirobot consists of a circular platform, driven by a direct current motor, through a transmission by a driving belt. On this platform, the second direct current motor is fixed, which, through another transmission by driving belt and through a worm-gear reducer, it sets in motion the driving element of the plane mechanism, with rigid, articulated elements [15].

Constructively, the plane mechanism with five mobile elements, seven cinematic couples of the fifth class, has the following particularities: $O_1A \equiv O_2B$; $O_1O_2 \equiv AB$.

In figure 2 it is presented the 3D geometric model of the studied system.

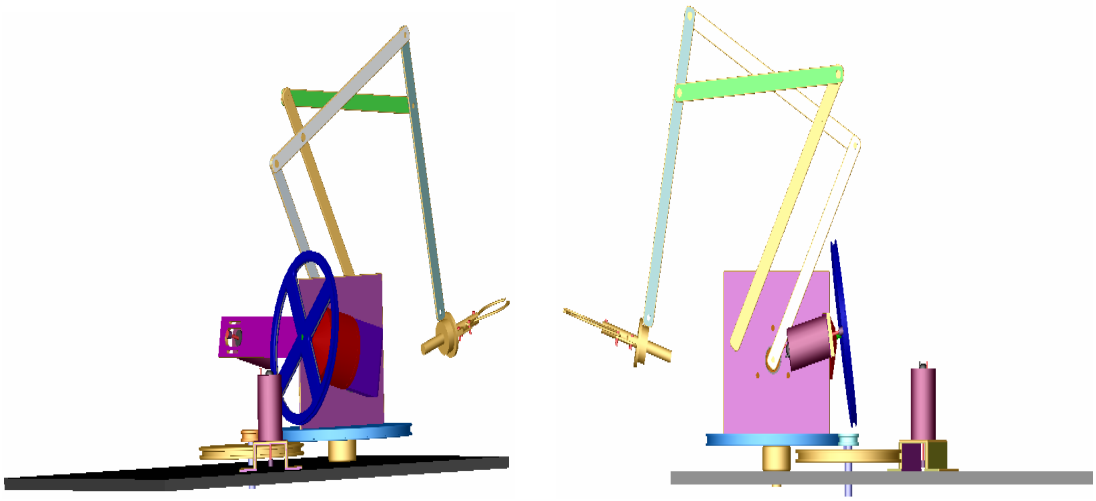

Fig. 2 The 3D geometric model of the minirobot

The simulation of the trajectory described by the end - effector of the robot after the immobilization of the joint O_0 is presented in figure 3.

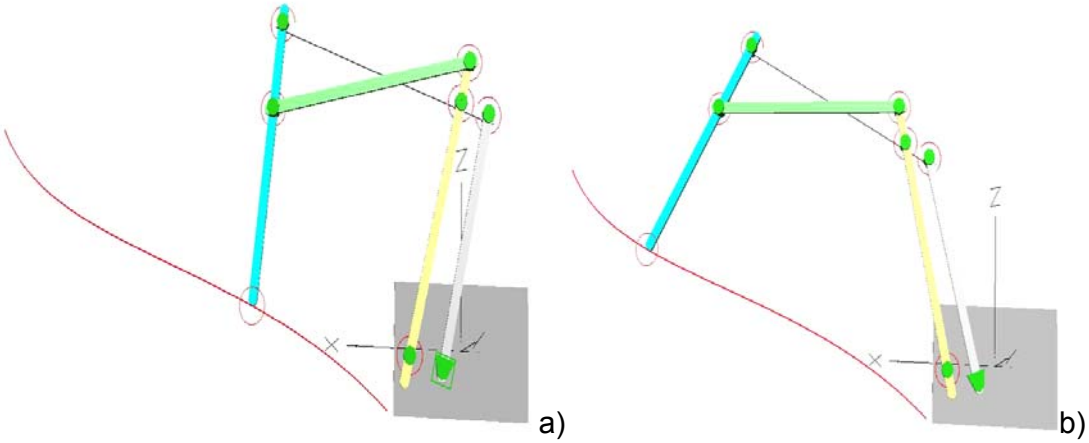

Fig. 3 The simulation of the trajectory described by the end - effector of the robot after the immobilization of the joint O_0

For the actuation of the robot are used two direct current motors of the HMR3604-010090 type, produced by the Japanese firm HOSIDEN. The movement amplitudes, both

of the basis platform and of the driving element 1 from the structure of the mechanism with articulated rods are limited constructively through the use of four path limiters.

The prehension device that is used is presented in figure 4. For its setting in motion an electromagnet is used.

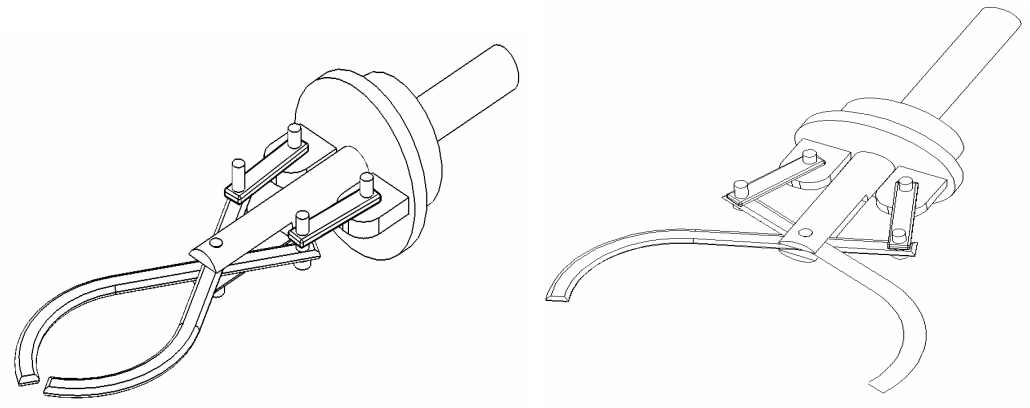

Fig. 4 The prehension device used by the minirobot

For the command system it was used a circuit that contains two H bridges (L293E) and a microcontroller ATMEL 90S2313 that communicates with the computer through a serial interface of the MAX232 type [1].

The L293E circuit, that we used, allows the two direct current motors to be commanded simultaneously.

The electrical diagram of the command system are presented in the following:

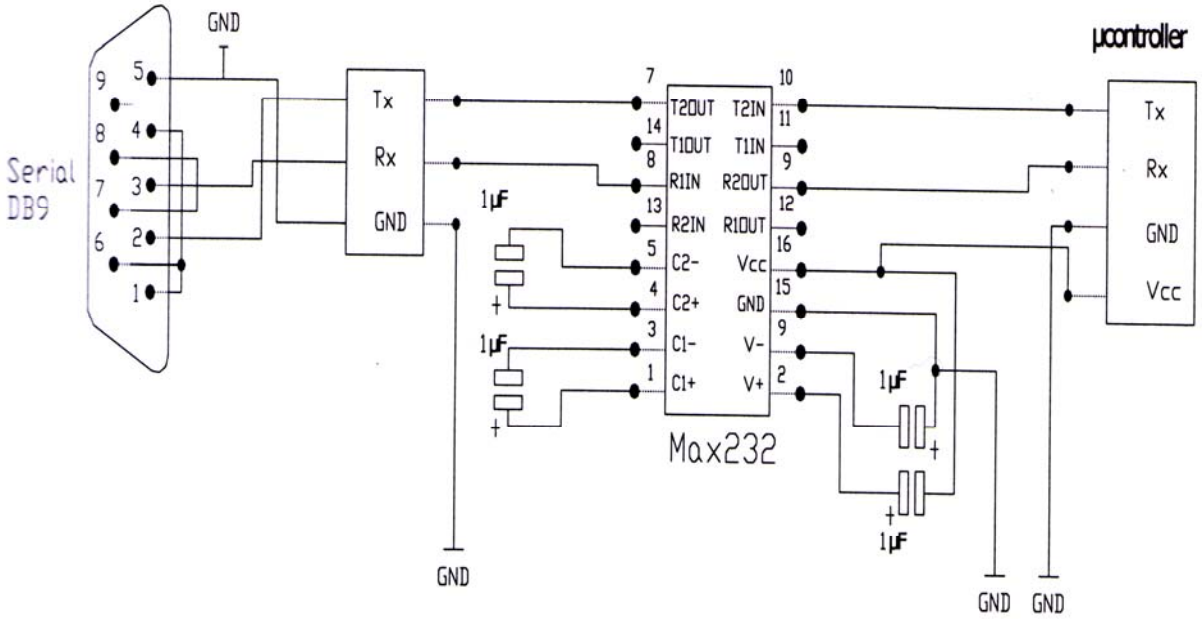

Fig. 5. The connection of the microcontroller to the serial interface

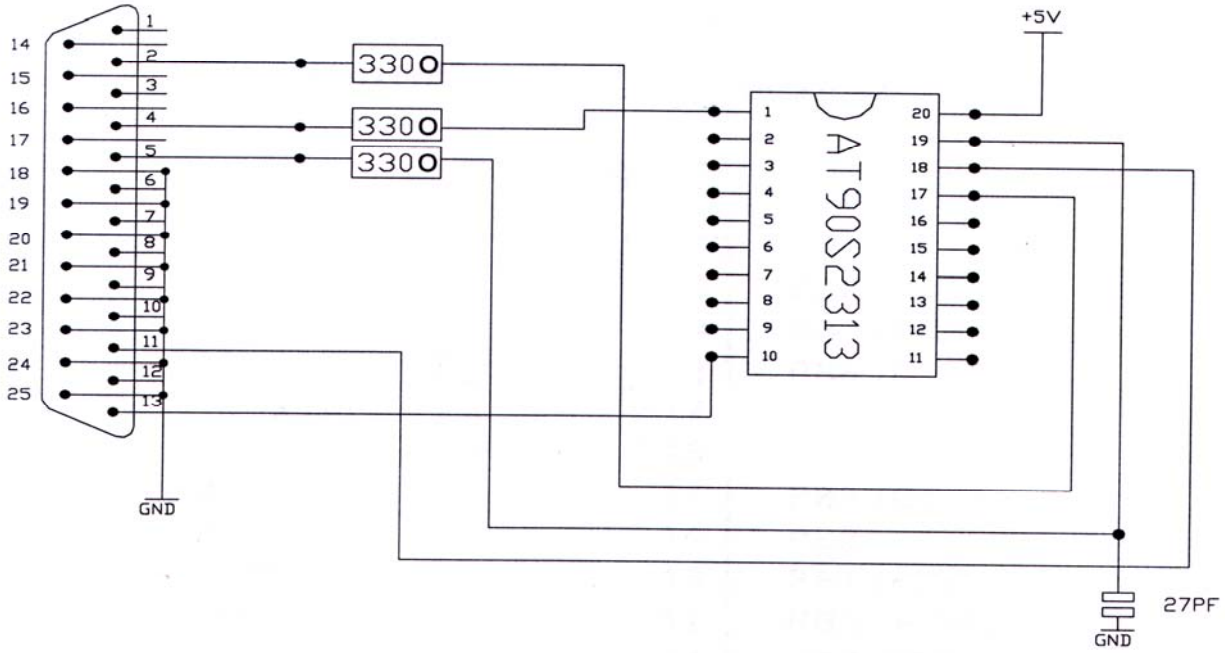

Fig. 6. The connection of the microcontroller to the parallel port

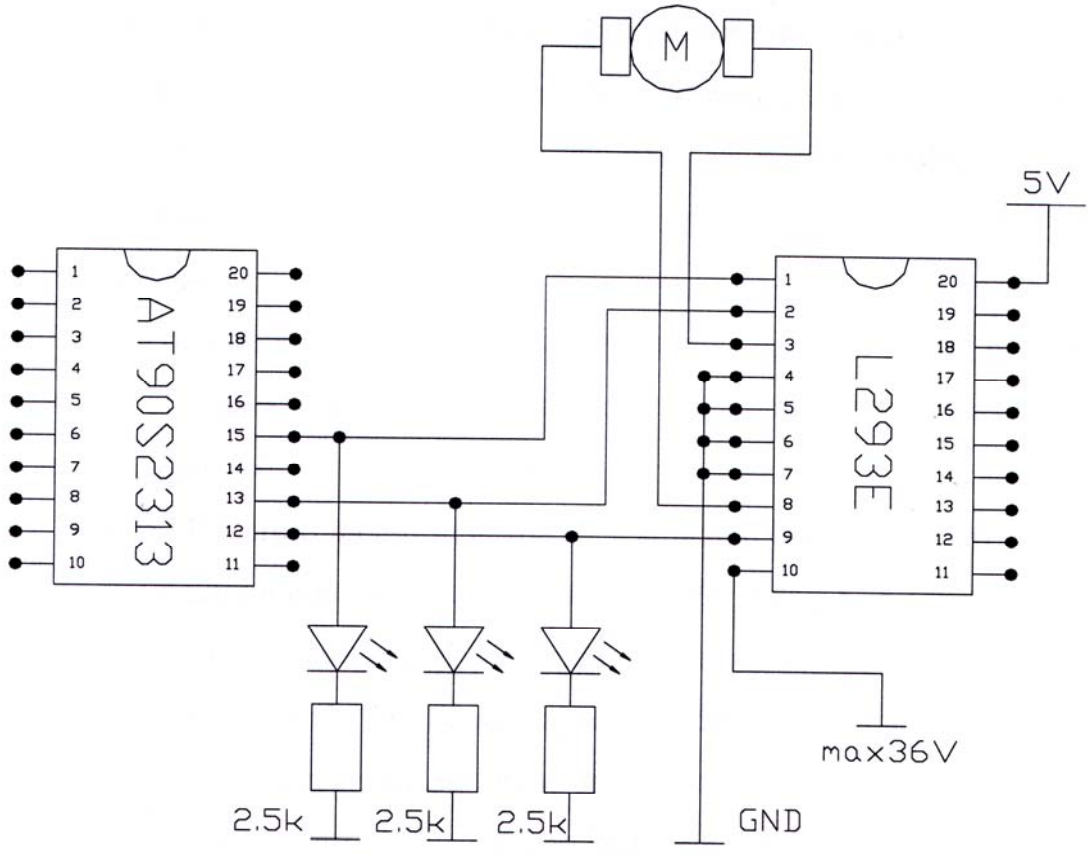

Fig. 7. The connection of the L293E circuit to the microcontroller

CONCLUSIONS

Through its object of activity, the rehabilitation engineering intends to improve the level of involvement of the individuals with disabilities in the economic and social life of the community, with a maximum level of independence, for a full display of their personality and for increasing the quality of life.

The present paper proposes systematization with respect to the functional role of certain robotic systems for rehabilitation. The authors also present the model the have chosen, the structure and the functioning of the developed prototype.

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