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CONCEPT OF MECHATRONIC SYSTEM FOR VISUALLY IMPAIRED PEOPLE

Isabela TODIRIȚE, Mihaiela ILIESCU, Emilia FURDU LUNGUȚ

Abstract: *This paper aims to highlight both the approach to the issue of assistive devices for the visually impaired, and to present a modular mechatronic system for visually impaired people who have acquired other mild or moderate disabilities during life or even from birth. The mechatronic system is not a conventional device, it can be customized when the person has adapted to the basic set and other needs have been identified in response to other needs through additional modules. Based on the needs and requirements of people with visual impairments identified by case study, a structure of the mechatronic system is designed, with special modules for location, color identification, object bypass, haptic / audio feedback.*

Key words: *modular mechatronic system, visually impaired, 3D modelling*

1. INTRODUCTION

Systems for people with disabilities were designed and then developed relatively recently, if we take into account the fact that since 1956, at the UN, an attempt has been made to create a legal legislative context through which the public was first needed to be aware of what health problems confront such people, to understand that they need the help of their peers, and all this to be put in a legal context such as a legislative convention.

This paper presents a review of assistive technology and is focused on the concept of a new innovative device for visually impaired who may have other conjugated/multiple disabilities as well, in different degrees, from birth or from different ages.

2. THE LEGISLATIVE FRAMEWORK IN ROMANIA

Understanding the problems faced by people with disabilities has been a crucial step in making them easier to integrate into those communities to which they belong, so that they can benefit from specific measures of protection and social and legal assistance according to their particular needs. based on the principles of respect for human rights and fundamental freedoms and the prevention and combating of discrimination (normative act called the United Nations Convention on the Rights of Persons with Disabilities).

In Romania, for example, the Cluj County Branch of the Association of the Blind was established on January 24, 1955, and in Bucharest at August 6, 1956, an association that during all this time tried to sensitize the Romanian public opinion about the problems that such people face.

With Romania's joining the European Union, an attempt was made to clarify the status of persons with disabilities, thus Law no. 448 din 06.12. 2006, on the protection and promotion of the rights of persons with disabilities, published in the Official Monitor of Romania, Part I, no. 1,006 of 18.12.2006, was amended by Law no. 241/2007, published in the Official Gazette of Romania, Part I, no. 496 of 24.07.2007, which then underwent many other changes to certain articles of law, through the Emergency Ordinance no. 84, of 20.09.2010, published in the Official Gazette of Romania no. 654 of 22.09.2010, changes being made even on 22.07.2020 [1].

3. REVIEW ON ACCESSORIES AND ASSISTIVE DEVICES

Over time, blind people have used the cane to identify obstacles on the road, which in the 1930s turned white in the USA [1] (see fig. 1).

France, and then more and more countries, in order to attract people's attention around the fact that the user is blind, the green one was added in Argentina in 2002 for partial blind persons (see fig. 2).

To warn those around the user that the one who uses it has poor eyesight, the white cane with red stripes, was introduced in England, so that it is known that the one who uses it suffers from deafblindness (see fig. 3).

The use of white sticks in open spaces, or in closed spaces outside the home, in some countries has become mandatory being regulated by law.

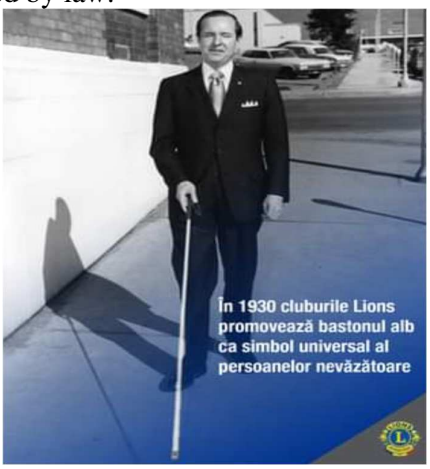

Fig. 1. Screenshot white stick for the blind, Lions Club Romania [2]

Fig.2. Screenshot green cane for the visually impaired [3]

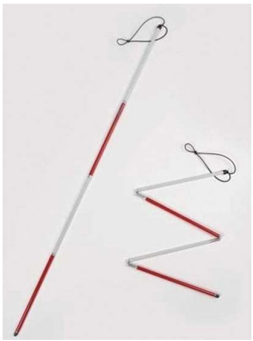

Fig. 3. Screenshot white cane with red stripes for the deafblind [4]

It has been noticed that the blind stick cannot provide safety while traveling, because the user wants to know what objects are around him, if there are obstacles in the road, what is the distance to those obstacles, if there are people around them, and if people are also from the circle of acquaintances, it would be good to know who they are. These impediments could be solved, at least partially, with the technological development, which allowed the creation of contexts for the development of assistive technologies.

Assistive technologies include all hardware and software solutions that enable people with disabilities to do activities that are comparable to those of a person without disabilities.

Assistive technology aims to create any "equipment or product used to increase, maintain or improve the functional capabilities of people with disabilities, whether it is commercially purchased, modified, customized" (WHO, 2011).

In this regard, the WHO (World Health Organization) is working to provide countries with practical recommendations and assistance in the field of assistive technology, issuing resolutions including "Disability, including prevention, management and rehabilitation" (WHO, 2005a) [5].

The European program "Facilitating the insertion of people with disabilities on the labor market" was implemented in Romania, which has as its first purpose the purchase of an assistive device, through a voucher, after having previously filled a file which was then approved by a specialized medical commission.

Assistive devices and technologies have been classified in Romania, according to the specific needs of people with such problems, as shown in Fig. 4. It can be seen that this classification includes devices that cover a fairly wide range of needs of the blind. Both white canes and smart white canes are included in the above list if we were interested in mobility. Another need they are preparing to overcome, for years, is to write, or to read. In this category we can note that it is specified that screen readers, software, Braille displays, etc. can be developed.

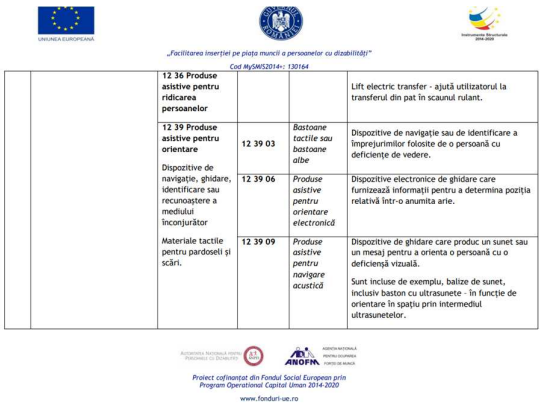

Fig. 4. List of technologies and assistive devices and access technologies, [6].

If the purchased device makes up for the disability, depending on the device's performance and the person's ability to adapt to new situations, it will allow the person with a disability to integrate more easily into the community, to think about what strategy to follow in order to integrate on the labor market.

Looking at the literature in other countries, one can see that there are broad concerns in classifying and implementing assistive devices and access technologies for the visually impaired [7].

The OrCam MyEye 2.0 assistive device, a medical device accredited in Romania, which can be purchased through a voucher, is addressed especially to people who still have some vision because, for example, the function of reading a text can be done by device, if the user points to where to start reading, which a blind person cannot do.

The WeWalk smart white cane is a device that uses Artificial Intelligence, it can also be connected to a smart phone. Such a device is useful for people living in cities, where the Internet connection operates in normal parameters, where databases with routes of public transport have been implemented, databases that can be accessed by the device. when the user is waiting for a bus at the station and can be notified by the device that in the next few minutes a means of transport arrives and to specify its number. This device requires user, because in addition to the fact that he must already know how to help himself with a white cane, he must also be familiar with the WeWalk software, hence with the menus on the smart phone, which once activated will notice when the bus or trolleybus arrives at the station. This type of device cannot be used by people with moderate cognitive impairment or by people who are not familiar with smartphone technology.

4. RESEARCH ON NEEDS AND REQUIREMENTS

This paper summarizes the scientific research conducted on a group of 47 subjects, with the aim of identifying the specific needs of both visually impaired and those with associated / multiple disabilities, including mild or moderate cognitive impairment, light or medium functional impairment (deficiency in statics or gait that make them able to move with some difficulty, unsupported, by their own strength).

Subjects range in age from 14 to 40 years. Given that some subjects are adolescents and others are at the age of maturity, it is observed that the people who participated in the study are in various stages of physical and intellectual development. In order to properly establish the range of needs it was necessary grouping the subjects by age. We have identified and focused on four age groups (see table1).

Table 1

Coding data on each group of subjects

Group Name	Participant coding	Number of participants	Range of participants Age
GrA	GrA1÷GrA15	15	14-18
GrB	GrB1÷GrB12	12	19-22
GrC	GrC1÷GrC11	11	23-30
GrD	GrD1÷GrD9	9	30-40
Total		47	

The subjects who participated in the study are students and follow a form of vocational, high school or post-high school education.

Another criterion chosen was whether the person is blind from birth, has become blind from childhood or adulthood, and has other disabilities. We wanted to know if both girls and boys have common needs for the group they belong to.

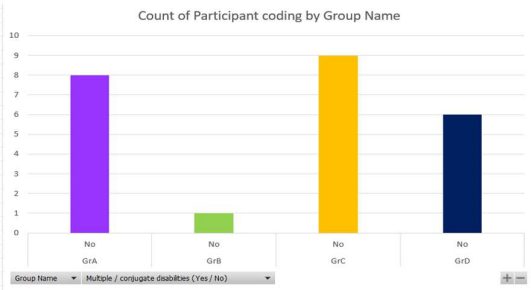

Fig. 5. Distribution by study groups of subjects who do not have multiple disabilities

The scientific research was based on data collected from the subjects:

- by applying special needs questionnaires,
- through roundtable discussions with subjects during face-to-face or online meetings.
- through practical field orientation activities in closed and open spaces; spaces whose configurations were known to them, but new routes unfamiliar to the subjects were also made.

Another criterion chosen was whether the person is blind from birth, whether became blind from childhood or adulthood, we correlated this criterion with the orientation in closed / open spaces so that we can then conclude for each group if it is relevant that for a shorter or longer period of time he / she had to or did not want to orient himself / herself and how this fact influences the orientation spirit.

In the next stage of research, we identified, grouped and analyzed the special needs of people with other disabilities. We were interested in how other disabilities influence the spirit of guidance.

Discussion on the obtained results are mentioned next. Subjects with visual impairments who were born with this disability responded differently to practical checks. They showed a sense of orientation in a closed space (even if it was unfamiliar to them), but in open spaces there were also subjects who, even if the space was known to them and who frequented it for 3 or 4 years, with an area of stretch of several hundred meters with non-linear alleys could not be oriented. I resumed the checks, modifying the route little by little, but I still did not get good results. Resuming the discussion about this phenomenon with the subjects, we were able to understand what was happening. Subjects who have parents, sometimes overly protective who induced insecurity in their own children, even if they are over the age of 18 and some of them refuse or cannot orient themselves, always waiting for help from those around them. and from another blind colleague.

They use smart systems (tablet, phone and even computer) only if they are pre-installed with synthetic voice software, they are not curious to try themselves for fear that they might break or fail to install applications on the play store or on external storage devices.

We also encountered the phenomenon of fear in front of the unknown in subjects with disabilities, only that they had a learning disability.

5. CONCEPT AND 3D MODEL

By analyzing the results of the study it was decided on the functionality of the mechatronic system's modules. The concept of the mechatronic system (see fig. 6) is that it can also be used by people with mild neuro-motor dysfunctions for helping to move, to be able to go up and down stairs. The robotic arm would help the blind person when there is a window on their way, as well as doors from open cabinets, to push / close them.

The design of the mechatronic device is highlighted in fig. 7. One can notice the whole assembly of mechatronic system – the locomotion module (mobile robot) together with the robotic arm module.

This system can be customized so that to help to move people with mild neuro-motor dysfunctions, being able to rely on its structure.

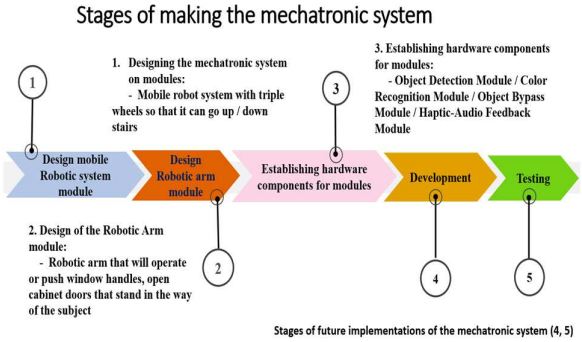

Fig. 6. The stages of obtaining the mechatronic system

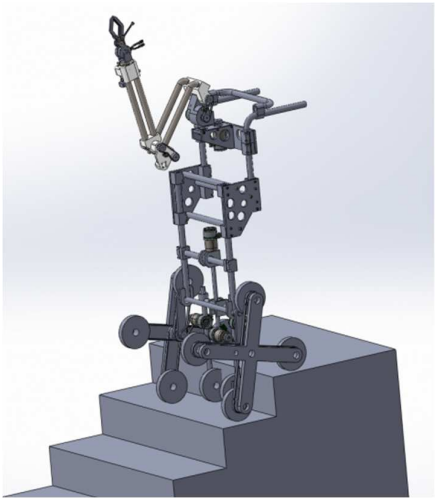

Fig. 7. Mechatronic system on stairs scene

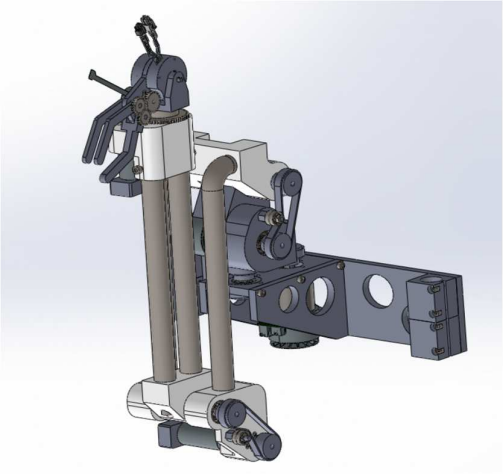

Fig. 8. Robotic arm module

In fig. 8 details of the robotic arm can be observed, details that highlight the method that will be applied in order to mount and fix the robotic arm to the system's frame.

The facilities of the mechatronic device will be available by the modular electronic systems (see figure 9).

The mechatronic device will have a command and control system provided by a central unit that with A.I. This system is intended to help the visually impaired people in challenging moments for them, such as bypassing obstacles in the way. In open spaces it will be possible to help these people by the AI module in order to know what is happening in the surroundings, if there are people in motion around them, static or moving objects, etc.

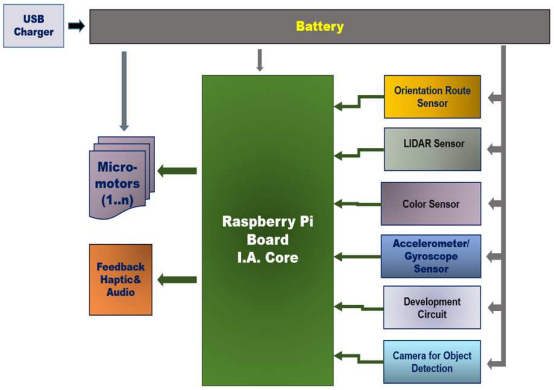

Fig. 9 Block diagram of Mechatronic System

The command and control system will be connected to modularly grouped elements, such as: detection and object location subsystem, subsystems that will contain LIDAR type sensors, cameras. The hardware subsystem will be supported by appropriate open source software to perform the functions mentioned earlier.

The color detection subsystem is designed either for the blind, as well as for the dyschromatopsia people and it is useful, for example, when the user has to choose clothes, or when he / she wants to wash in the washing machine and needs to know the colors of the clothes to be washed.

All these subsystems will be implemented in the development phase. For each developed subsystem, the 5th step of the test (see figure 6) will follow. Subjects will be involved in the testing phase, and this stage will gather haptic and audio feedback for the modular subsystems involved in this research.

6. CONCLUSION

This paper aims both to address the issue of assistive devices for the visually impaired and to the concept of a modular mechatronic system for visually impaired people who have acquired other mild or medium deficiencies during life or, even from birth.

This system is intended to help the visually impaired people with bypassing obstacles in the way, with knowing what happens in the surroundings, if there are people in motion around them, static or moving objects, etc.

In fact, this research aims to create a modular mechatronic system and as the visually impaired person identifies other needs than the basic set it is equipped to, other facilities and, corresponding modules, are to added.

At first there will be a period of adjustment with the device, as training period. Each subject will benefit from a personalized training period and depending on the progress made will be able to benefit from a system adapted to specific personal needs. If he exceeds this threshold, he will be able to use the mechatronic system in his daily life.

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CONCEPT AL UNUI SISTEM MECATRONIC PENTRU PERSOANE CU DEFICIENȚE DE VEDERE

Rezumat: Această lucrare își propune să evidențieze atât abordarea problematicii dispozitivelor asistive pentru persoanele nevăzătoare, cât și să prezinte un sistem mecatronic modular pentru persoanele cu deficiențe de vedere care au dobândit alte deficiențe ușoare sau medii în timpul vieții sau chiar de la naștere. Sistemul mecatronic nu este un dispozitiv conventional, el poate fi personalizat atunci când persoana s-a acomodat cu setul de bază și au fost identificate și alte necesități ca răspuns la alte nevoi prin suplimentare de module. Pe baza nevoilor și a cerințelor persoanelor cu deficiențe de vedere identificate prin studiu de caz, se proiectează o structură a sistemului mecatronic, cu module speciale pentru localizare, identificare a culorilor, ocolire obiect, feedback haptic/audio.

Isabela TODIRIȚE, PhD student, MSc. Eng., Institute of Solid Mechanics of the Romanian Academy, Department of Robotics and Mechatronics, todirite.isabela@imsar.ro, +40 213126736, Constantin Mille 15, Bucharest, Romania.

Mihaiela ILIESCU, Habil. PhD. MSc. Eng., Senior Researcher, Institute of Solid Mechanics of the Romanian Academy, Department of Robotics and Mechatronics, mihaiela.iliescu@imsar.ro, +40 213126736, Constantin Mille 15, Bucharest, Romania.

Emilia FURDU LUNGUȚ, PhD. Senior Doctor in Neurology, Lecturer at Titu Maiorescu University, CF2 Hospital, lungut.emilia@yahoo.com, +40 213126736, Mărăşti 63, Bucharest, Romania.