# BIOMECHATRONIC DEVICE USED FOR ASSISTING PEOPLE IMMOBILIZED IN BED

**Ionel Şerban[1], Cornel Drugă[1], Ileana Constanța Roșca[1], T. Jugaru[1]**
[1] Transylvania University, Brașov, România, druga@unitbv.ro

***Abstract:*** *The paper presents the design and realization of a biomechatronic system for assisting persons immobilized in bed.. In essence, this system consists of two motors, so one of them provides a translational movement in the vertical plane, and the second engine performs the translational movement in a horizontal plane. Also, the way the system is used is designed to be simple, so that each elderly person can use it alone and safely. The system is commanded by a simple remote control. The system is also provided with a harness that makes it possible to catch the person to be lifted off the bed.*
***Keywords:*** *Biomechatronic, motor, translational, locomotor system, winch.*

## 1. INTRODUCTION

With the passage of the years, the human organism is experiencing a continuous degradation, in some cases more accelerated and in others slower. Among the many dysfunctions of the elderly, we mention the degradation of the locomotor system, the degradation of the visual system and the sensory system. Because of this, many people get to travel problems and others get stuck in bed. The ability to move people is important, and the inability to move can mean a real trauma that negatively affects self-esteem as well as mental well-being [1].
The optimal operation of the locomotor system depends on the smooth operation of the sensory system, which in turn consists of the visual, vestibular and somatic. As has been remembered, the ability to perceive and visual acuity decrease with age. The vestibular system, in most cases, is affected by the aging process. Old age has severe consequences on the loss of peripheral information of the somatic sensors, on the stability and balance of the body. That's why many elderly people are prone to falls, and if osteoporosis affects their bone system, fractures are inevitable. The accumulation of age-related illnesses may worsen and may complicate the problems of the locomotor system. The implementation of the Biomechatronic Device used for Assisting People Immobilized in Bed, comes as a response, following the identification of the specific needs encountered among the elderly. These needs relate to the operating difficulties of the locomotor apparatus

## 2. LIFTING TECHNIQUES FOR EARLY PEOPLE

To lift people out of bed, assistants need to develop some techniques to protect themselves. It must also take into account certain factors such as: the height and weight of the patient, the patient's ability to work with the person lifting him, the ability to maintain balance. The patient can greatly help the person who will make the effort of lifting through the power of concentration and following the received orders. However, following the careful assessment of these risk factors, the person who helps should be prepared for unexpected situations [1], [2], [3].
The physical therapist should also take into account the condition of the patient, whether it has lesions, whether it has the capacity to collaborate, whether it has recently undergone surgery and how it is connected to tubes or has limbs attached. Account must also be taken of the patient's mental state, hostility or agitation. The lifting technique used must be safe for both the patient and the person who helps. Some older people can sit upright, but to get into the bipedal position they need help. The person who offers them will consider lifting them in the biped position by placing their hand under the shoulder region and the other under the knee. In order to make the maneuvers necessary for lifting easier, people immobilized in bed can catch the caregiver's neck [3], [4].
In other cases, when the person is immobilized and cannot get into a sitting position, two people are needed. One person will put his hands under the shoulder blades and the other will put his hands under his knees. The movements will be synchronized as the old man is raised back and forth and positioned at the edge of the bed.
After the old man is seated, sitting on the edge of the bed, the caretaker will sit in front of the old man, fix him with his knees, the elder's knees, and with his hands he will hold it under the axes. The old man will cling to his

shoulder or the neck of the caregiver and by pushing the assistant's knees, the caregiver's center of gravity descends, thus increasing the lifting force of the assisted person. If there are two caregivers, they will catch each old man under the axillary and simultaneously lift him up. [5]
Techniques to be applied by a healthy person who wants to lift an immobilized person from the bed to avoid muscular injuries should be chronologically included in the following steps:

- Open communication between the person who helps and the patient. Through this communication, the patient will strive to cooperate to the extent that he can do so;
- Careful removal of the legs from the shoulders. Maintaining a correct body biomechanics throughout the maneuver;
- Place one leg approximately half a foot ahead of the other leg;
- Flexing the hips and knees;
- Attaching the leg muscles to lifting the immobilized person;
- Contraction of abdominal muscles and buttocks;
- Straightening your hands to the patient, avoiding the rotation of the trunk and knees;
- Straightening the toes in the direction of the person to be lifted;
- Expiration at the time of lifting;
- Creating a lever and good control over the person to be lifted from the bed. It is known that the effort increases directly in proportion to increasing the distance between the center of gravity of the person carrying the lifting effort and the person to be lifted. Only one hand should be lifted of the immobilized person;
- Lift the person smoothly not suddenly, immobilized by approaching the body of the lifter. The proximity of this person facilitates greater control over the movement. Changing the direction or rotation will not be done at the trunk but at the level of the legs.

## 3. ELDERLY CARE SYSTEMS

For lifting the fixed persons from the horizontal position or from the sitting to the biped position, different devices or frames can be used for this purpose. They ease the lifting process and some provide a dose of patient independence so they do not depend on assistants.
Also, the use of certain lifting devices or systems offers several advantages such as:

- Facilitating the immobility of the immobilized person;
- Maintaining the patient's dignity;
- Reduce the risk of musculoskeletal lesions of both the lifter and the patient;
- Providing patients with a safer feeling of comfort during handling.

Below we will present the assistance systems found on the market.

### 3.1. EZ STAND-N-GO Device

Another device available on the market that helps the person get into the biped position is the EZ Stand-N-Go that supports the lifting process from the bed and the ergonomic handle ensures adhesion to get to the feet safely. The device is adjustable to suit a wide range of beds and sofas. [6], [7] This device may only be used by the person alone who can help him / her sit in a sitting position.

**Figure 1:** EZ STAND-N-GO Device

### 3.3. Stand-up Get-U-Up Lift

Another device is the Get-U-Up stand-up lift. This device is ideal for use by middle-weight patients as well as those who need support for rehabilitation, the Get-U-Up stand-up lift offers safety, comfort and stability (Fig.2). [8] This device can be used by patients who are able to maintain their balance and a little of a lower limb and can grasp the device with one hand. The patient must be trained in advance and have the ability to follow the instructions.

**Figure 2:** Get-U-Up Hydraulic Stand Up. [8]

The systems outlined above can only be used in certain cases. Thus, the EZ Stand-N-Go and the Get-U-Up stand-up lift can only be used by seated and stable persons. The advantage of the system that we do is that it can also be used by immobilized people who do not have the power to sit up [8]. Lifting straps can be applied by the elderly person even without the need for extra help. This gives a minimum of independence to older people with mobility problems [9].

## 4. DESIGN OF BIPED POSITION ASSISTANCE SYSTEM

There are several ways to lift elderly people from the horizontal to the bipedal position. Thus, the most common way is that a healthy person, an assistant or someone in the family helps the elderly person get up from bed. This action, however, in some cases involves considerable physical effort. We refer to the fact that some people are overweight or others because of physical inability, cannot work with the person who wants to help. Also continuing addiction to someone can affect self-confidence.

The seat assist system for the elderly was designed to be a simple system and can be used efficiently by any person in need of assistance. The system is practical and easy to use by the recipient. Also, placing the system above the bed meant that it could be used whenever the patient needed to be lifted in the bipedal position.

The system was designed to have two DC motors (fitted with reducers) so one of them would provide the vertical translation of the immobilized person and the second engine to execute the translational motion in the horizontal plane. Also, how to use the system is a simple one, so that each elderly person can easily use it.
The system is powered by a remote control and a three-position switch. The device is also provided with a strap system for lifting the immobilized persons. A brief briefing on how the system works is useful and practical to understand how this system works. Another benefit of this system is also provided by controlling the rotation speed of DC motors. In designing the bipedal positioning system for elderly people, it was taken into account that both physical vigor and reflexes of elderly people are affected by muscular atrophy, so the system offers a smooth and not a sudden lifting.

### 4.1. Design of assistance system

The design of the system was carried out in the CATIA program due to the facilities offered by this program as well as the personal experience accumulated. CATIA supports several stages of product development, design, manufacturing, and analysis. The concept is based on a simple, reliable and yet easy-to-use architecture that can be used on a Windows platform.
A wide range of industries use CATIA. The most important of these are: the aerospace industry, the automotive industry, the shipbuilding industry etc.

The metal frame has a height of 2000 mm and the distance between the posts is 1500 mm. The metal frame (Fig. 3.A) has a good stability due to the shape and the materials used (four round pipes with a curved shape, the distance between the pipes being 1200 mm).

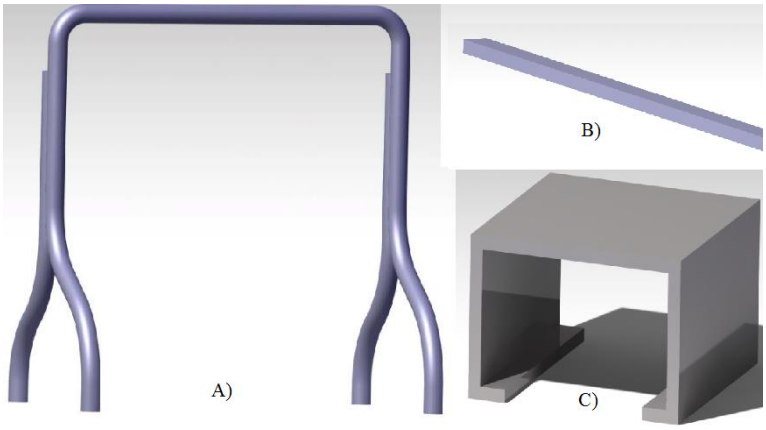


**Figure 3:** A) metal frame; B) aluminum profile; C) special clamps.

An aluminum profile (Fig. 3.B), with a length of 1500 mm, a width of 40 mm and a thickness of 4 mm, attaches to the metal frame by means of special clamps (Fig.3.C). Inside the profile, the trolleys will slide for the translation movement. In the case of horizontal displacement, the rotation motion of the electric motor (24VDC) turns into translation motion by means of a square screw and nut (Fig.4). The connection between the screw and the electric motor shaft is achieved by an elastic coupling.

**Figure 4:** Assembly consisting of nut and clamping flange

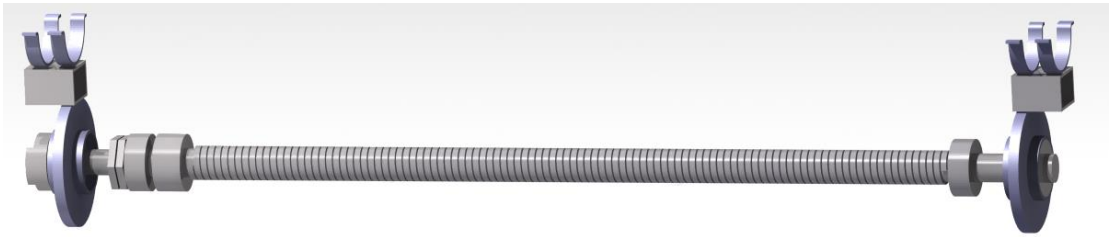

**Figure 5:** Assembling the screw with flanges, bars and collars

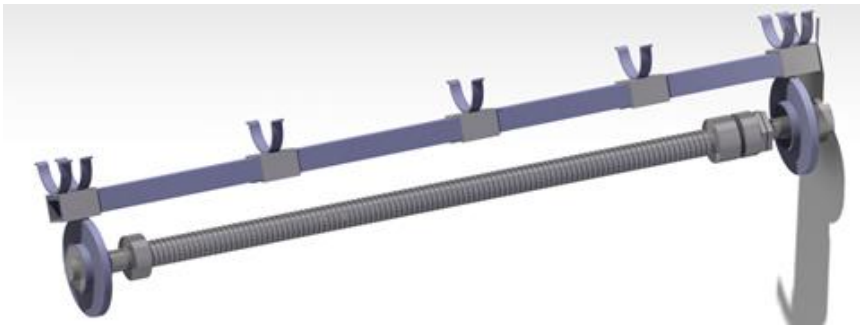

**Figure 6:** Assembling the square-screw screw and the profile for the translation

Figure 5 shows the assembly between the square screw, flanges, and the clamping mechanism on the frame of the system, consisting of squares and squares. The flanges attached to the threads of the threads make it fastened to the metal frame and to the guide bar by means of square shaped pieces.


**Figure 7:** The 24 V electric motor and winch used to drive the immobilized bed care system

The assembly between the square screw and the aluminum profile is made by means of the flanges attached to the ends. Along with these pieces there are square bars with collars that are designed to catch the whole metal frame on the metal frame (Fig.6, 7). The system is fixed by a metal frame through the 7 necklaces and 5 pipe segments that provide stiffness. After this step, follow the choice of the electric motors and their attachment to the system. A winch was used to pick up or lower the immobilized persons from the bed (Fig.8).

The winch is equipped with the control system and is also powered by a 24V DC voltage. With the reducer that it has embedded, it optimizes the vertical movement. The winch's steel cable has been replaced with a synthetic, durable strap with a hook attached to it. This hook will attach the harness to support the patient. The ham is an important device in the beep position assist system (Fig.9). The lifting and transfer of patients is possible with the harness. There is a wide variety of harnesses on the market, ranging from simple to complex harnesses, used for varying degrees of mobility. The ham used in this work is simple but appropriate because the assisted person has to reach the bipedal position.

**Figure 8:** The final version of the system

## 5. CONCLUSIONS

The system has a simple and efficient way to use it. This device will be placed above the bed where the immobilized person is. The system user will operate the engine that performs the translation and the operator executing the lifting, by remote. The motors will be connected to a 24V DC source.
First, the assisted person will have to execute the necessary commands to get the device in a position favorable to use. The 24 VDC motor will perform the translation movement via the attached remote. He will have to move the trolleys with the attached system so that it gets above the patient. Switch with positions 0, 1, 2, inverts the meaning by reversing the plus and minus polarity. The person in which the person is lifted at a convenient distance from the bed will retract the finger on this button. The positioning of the patient near the bed is done by means of the translational motion of the 24VDC motor driven by the built-in remote control. By actuating position 1, the motor will move the person to the right, and by actuating position 2, the motor will move the person to the left. After positioning the person next to the bed, it will be lowered vertically, with the remote control acting on the winch until the person has contact with the ground and manages to regain his balance. When the person is in the biped position he will remove his support harness.

## REFERENCES


[1]. R.S. Johansson, Å.B. Vallbo. Spatial properties of the population of mechanoreceptive units in the glabrous skin of the human hand. Brain Research (vol 184). 24 02 1980, pg. pag. 353-366.
[2]. Dingwell J.B., Cusumano J.P.,Sternad D.,Slower speeds in patients with diabetic neuropathy lead to improved local dynamic stability of continuous overground walking, Jornal of Biomecanics vol 33, pp. 1269-1277, 2000.
[3]. Livingstone C., Foot Problems in Older People: Assessment and Management. Philadelphia, USA : Elsevier Limited, 2008.
[4]. Iezzoni L.I., When Walking Fails, Mobility Problems of Adults with Chronic Conditions, Los Angeles: University of California Press, pp. 18-19, 2003.
[5]. Evelyn K., Obesity . Westport CT: Greenwood Press, 2006.
[6]. Curea de transfer - PerVita - Tratament Escare, Produse Hartmann, Ingrijire Bolnavi. PerVita - Tratament Escare, Produse Hartmann, Ingrijire Bolnavi., [Accessed: 08 10 2018.] https://www.pervita.ro/produse/ingrijire-bolnavi/accesorii-ingrijire-bolnavi/curea-de-transfer/.
[7]. Stand-N-Go, EZ. EZ Stand-N-Go | Product Review. AgingCare. [Accessed: 10.10.2018] https://www.agingcare.com/Products/ez-stand-n-go-211006.htm.
[8]. Lift, Get-U-Up. Get-U-Up Hydraulic Stand Up Lift | Product Review. AgingCare, [Accessed: 11.10.2018.] https://www.agingcare.com/Products/get-u-up-hydraulic-stand-up-lift-434675.htm.
[9]. Chiari L., Rocchi L., Cappelo A. Stabilometric parameters are affected by anthropometry and foot placement. Clinical Biomechanics vol 17, pp. 666-667, 2002.