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INNOVATIVE MECHANICAL STRUCTURE FOR HOSPITAL BED FOLDING USING A SINGLE ACTUATOR

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Abstract: *The paper present an innovative concept of a hospital bed which use a single drive to transform the bed into a chair. The bed concept fits into the concept of smart care and tries to address the increasingly complex needs of patients who are in a convalescent period. The hospital bed is smart, allowing the patient to choose a more ergonomic and comfortable position, The transformation of the bed to chair can be done with the patient on the bed. Once transformed into a chair it can pivot around a vertical axis to give the patient the opportunity to get up on any part of the bed. Pivoting also offers the possibility to perform recovery exercises from a sitting position and to socialize with other patients.*
Key words: *CAD, ergonomics, smart equipment,*

1. INTRODUCTION

Hospital beds are important elements of the patient care system. The beds provide comfort for both the patients and medical staff that support the patients and monitor their health. The research presented in [1] shows that non ergonomic design of the hospital beds can lead to back injuries, fatigue and other injuries among the nursing staff. An ergonomic hospital bed contributes to a better patient comfort, it offers better mobility inside the hospital and it also improves the safety. A very important function of a hospital bed is to transfer the patient from the bed to various medical equipment or systems as well as the possibility to offer the patient tools to call for help. The bed concept presented in this paper fits in the concept category of "Smart hospital beds". This type of bed provides all the functions provided by standard hospital beds but it also has additional function and features which increase the patient`s comfort. The research presented in [2] highlights the importance of using IT technologies to convert conventional equipment in smart equipment to better support patients. This process can increase the degree of independence of patients in various steps regarding their hospitalization process.

2. HOSPITAL BED CONCEPT

The hospital bed concept has been developed using a TRIZ based methodology similar to those presented in [3- 6]. Unlike other models available on the market (fig. 1) or concepts, the hospital bed presented in this paper uses a single engine to transform the bed into a couch.

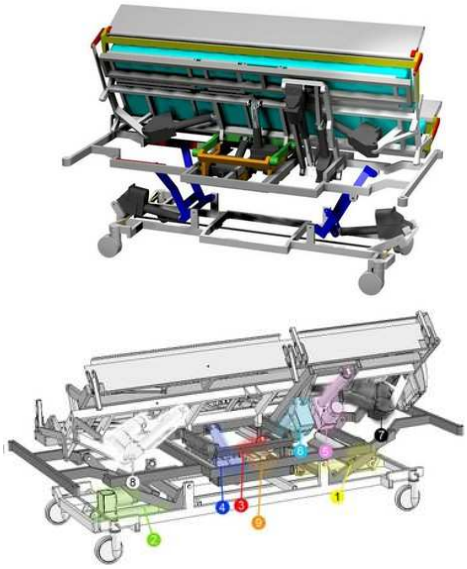

Fig. 1. Other hospital bed mechanisms [7]

The transformation can be done with the patient on the bed. Once transformed into a couch it can pivot around a vertical axis to give the patient

the opportunity to get up on any part of the bed. Pivoting also offers the possibility to perform recovery exercises from a sitting position, socializing with other patients by orienting two beds face to face in coach position

The main focus of the development of hospital bed is to create a "personal environment" that can improve the patient's comfort. The bed will be equipped with a retractable dome like the one in the figure below (presented by Intel at CES 2016), which allows the creation of a private environment when the patient wants it.

Fig. 2. Intel dome for relaxing (photo Neamtu C. at CES 2106 Las Vegas)

This dome is equipped with connection to a refreshing and purification air system, also allows the control of lighting inside of it (such a patient can read at night without disturbing others), it has support for a 1- inch tablet and can be equipped with a noise cancelling system. One of the innovations which represent this bed is the presence of a sensor system. This sensor allows the bed to take care of the patient. A tracking system like Microsoft Kinect can modify the position of the patient on the bed.

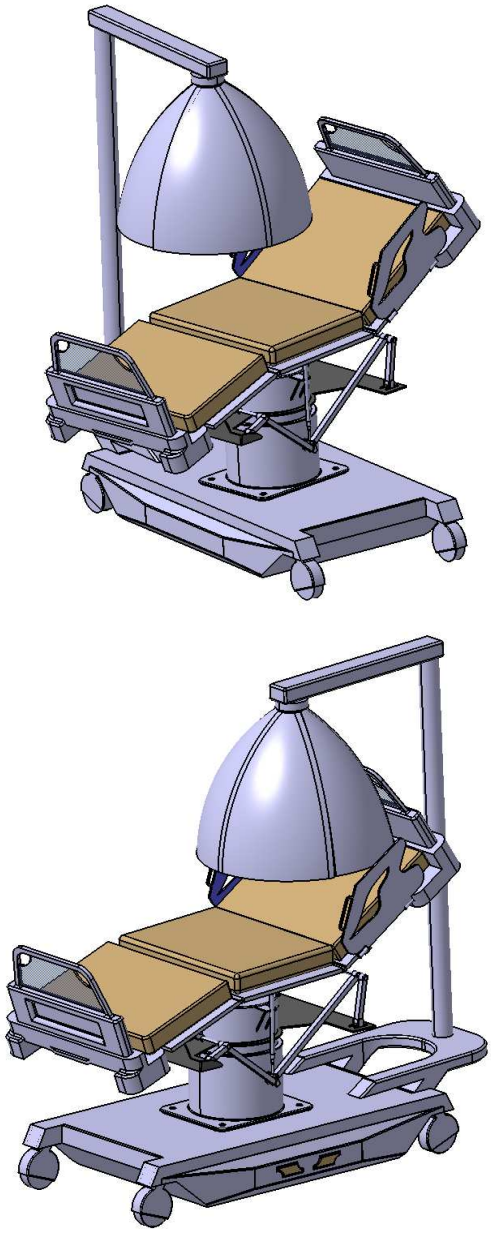

Fig. 3. Dome position

The "personal environment" system allows the patient to create a private space by opening the dome that allows the user to temporary be isolated from the rest room. Inside the dome the user can control the conditioning air intake using a refreshment and filtration system. The dome is equipped with a tablet that enables the possibility of changing different settings of the bed and the inside environment of the dome (position, light or climate), the system can be used as a multimedia system or and e-reader platform. The current beds available on the market are using different curtains system in order to isolate the patients.

An extra advantage of the proposed dome system is focused around the possibility of creating a microclimate around the patient in which it can control different aspects such as the light, temperature and air quality. This system is suitable only for patients that are not suffering from claustrophobia.

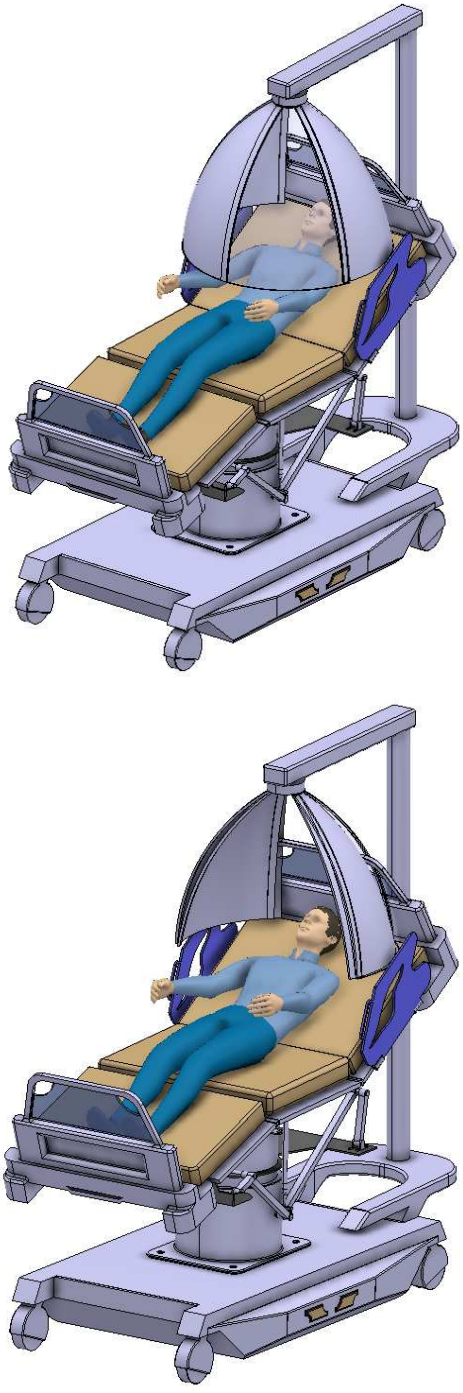

Fig. 4. Using dome for personal environment

The proposed dome (fig. 4) is composed of four segments that fold two by two behind the bed at the head position of the patient. This area represents the location of the tracking system and the thermal camera.

Another sensor that is mounted for the supervision of the patient is a thermal imager camera and a WI-FI transmission, it can monitor the patient's temperature continuously and if the patient exceeds a given level the system sends an alert to the centralized patient management system. The construction of the bed will be made with metal, plastic and composite materials. Most components of the bed which will be in contact with the patient will be made of composite materials with silver ions in composition [8] to decrease the risk of contamination.

One of the innovative elements of this bed is the mechanism developed by the authors, the mechanism is used for folding the bed shaped chair. This is done using a rod mechanism, the proposed mechanism is illustrated in Figure 5. Using a single electric actuator it is possible to transform the bed into an armchair using a translation movement applied within one point of the bars system.

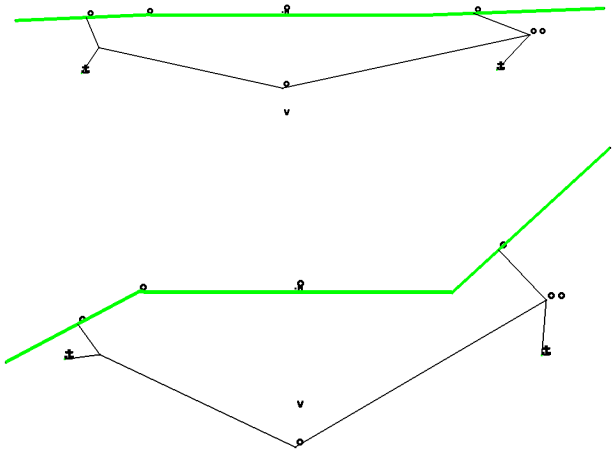

Fig. 5. Mechanism for hospital bed

The bed is structured using three segments which together with the bars mechanism compose a module that can be rotated horizontally and it can also be lifted vertically to facilitate various operations such as the transferring of the patient or to flip patients with a very low degree of mobility. The validation of the mechanism was achieved using cinematics simulations of the components that define the mechanical structure of the proposed bed. The

product design has been done using CATIA V6 and the study regarding the ergonomics and possible patient postures on the bed where simulated in DELMIA V6. A preliminary finite element analysis was performed on the main structural elements of the bed.

7. CONCLUSIONS

Another novelty element of the proposed concept is the self-care system that uses a tracking system and a body measuring temperature in order to take "care" of the patient by changing the position of the bed so that the patient will natural change their position at different preset time intervals. Compared to other models from the specialized literature there aren`t any reports regarding a position tracking system that allows the patient to avoid bedsores.

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STRUCTURA INOVATIVĂ MECANICĂ PENTRU UN PAT DE SPITAL FOLOSIND UN SINGUR ACTUATOR

Rezumat: Lucrarea a prezintă un concept inovator al unui pat de spital, care utilizează un singur motor pentru a transforma patul într-un fotoliu. Conceptul de pat se încadrează în conceptul echipamentelor de îngrijire inteligente și încearcă să abordeze nevoile din ce în ce mai complexe ale pacienților care se află în perioadă de convalescență. Patul de spital inteligent permite pacientului să aleagă o poziție mai ergonomică și confortabilă. Transformarea patului in fotoliu se poate face cu pacientul pe pat. O dată transformat într-un fotoliu, acesta poate pivota în jurul unei axe verticale pentru a da pacientului posibilitatea de a se ridica pe orice parte a patului. Pivotarea oferă, de asemenea, posibilitatea de a efectua exerciții de recuperare dintr-o poziție șezând și oferă o postură mai bună pentru a socializa cu alți pacienți.

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