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A WHEELCHAIR SOLUTION WITH SOLAR PANELS

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Abstract: *The wheelchair in general is a vital mobile tool for people with disabilities. On the Romanian market there are only classic seats (with manual action) that cause injuries to the upper limbs and acute fatigue to users. There are also electronic chairs that have a much lower risk of damage to the osteoarticular system of the upper limbs, are designed for more efficient handling, but have a higher price. In this article we provide details on the design and operation process of a wheelchair with electric propulsion supported by an auxiliary solar power supply system. Following a test, it was observed that the solar power supply can increase the travel radius by 26%, compared to the solution that uses a battery power supply (with electronic drive system). The solar panel of the wheelchair will also serve as user protection against external factors, such as: excessive solar radiation or precipitation (snow, rain). We intend also, the economic development of the solar wheel scan in the form of a social enterprise, that certain processes, activities of the technological flow can be performed by people with disabilities.*
Key words: *Solar wheelchair, prototype, design, urban mobility, social business, inclusion.*

1. INTRODUCTION

In general, the design and functionality of solar wheelchairs primarily affect user mobility. Additions regarding the design of the equipment and the energy source used for control determine the overall performance of the mobility. The solar wheelchair determines the stability and efficiency of mobility, being the most suitable solution for the needs of users at the moment. Specialized research shows that the user of wheelchairs needs a continuous improvement of technology and wheel assembly, because it is the key to kinematic movement [8].

There are few studies in the literature that present research approaches to the design of durable wheelchair solutions, most of which are debated topics on use, operation and ergonomics or medical issues to reduce endurance and prevent user injuries while walking [14].

The latest research on the wheelchair kinematic system shows that applying a renewable energy source to the wheelchair provides a sustainable utility for the user [2].

The objective of the thesis is the design and physical prototyping of a solar wheelchair through which with the help of photovoltaic cells can convert solar energy into electricity, energy needed for the electric motor attached to the seat with energy storage in the battery [5].

In the design process of the chair, points such as ergonomic design with the importance of economic and social impact at the community level are considered. By improving mobility, the proposed solution is also associated with the integration of people with disabilities in the family, society and to provide an improvement in daily tasks [3].

2. LITERATURE REVIEW

According to the literature, the first electric wheelchair appeared around the 1950s necessary for wounded war veterans. Chair considered at the time an effective invention aimed at change and the chance of independence in mobility [13].

Usually an electric chair comes with the related advantages but also with small inconveniences such as in case of a malfunction, the repair is expensive. Electric models that use conventional energy for recharging are not accessible to an ordinary person. From a medical point of view, a wheelchair makes a person deliberately carry out their daily activities [13].

This paper proposes a prototype, at an optimal cost, to serve people with motor disabilities. We also thought if placing the prototype in the form of a social project will bring innovation in transport for disadvantaged people. To achieve full mobile freedom, in recent years economic operators have designed and manufactured scooters and wheelchairs, both manual and electric [6].

Technological advances have led to several options available by attaching devices that have allowed people with disabilities to travel comfortably beyond their own homes. In the past, people didn't like electric chairs because of their short battery life. At present, the capacity of the batteries has improved in terms of movement, without the need for recharging, and the design of the solar wheelchair will bring a note of performance. The adaptability of people with disabilities over time has led to wonderful inventions, which today offer advantages that the world of mobility has not done so far [12].

The proposed solution provides facilities for a wide range of people with disabilities to help them perform their usual tasks, promotes the concept of sustainable development which can lead the user to a high sense of responsibility for the environment [1]. This product, designed for people with disabilities and the elderly, is a vast business opportunity from a social point of view for the community in a sustainable way [8].

As can be seen in the table, wheelchair users cannot enjoy walks on the beaches, nor can they easily cross the bumps or stations on the routes. Researchers in the field have tried to solve this specific problem but it seems that the community in which the implementation is desired also differs from case to case. That is why it is necessary to intervene in such a proposal with a customized solution adapted to the market so that economic operators can carry it out [5].

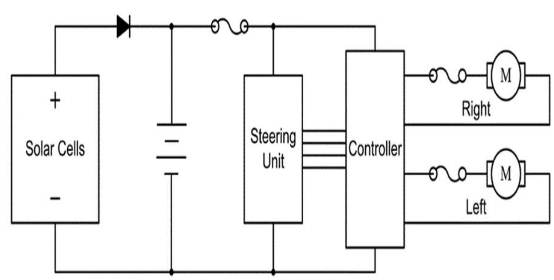
3. DESCRIPTION OF THE PRODUCT AND PROJECT SOLUTION

The methodology of this paper began with a market study in the form of a questionnaire on attaching a solar photovoltaic system to a wheelchair for people with disabilities. With the help of the questionnaire we obtained a vision on the types of wheelchairs available on the market and beyond. The trend to buy solar wheelchairs has aroused market interest because they are cheaper, have a lifespan of 5 years and can be easily recycled [3].

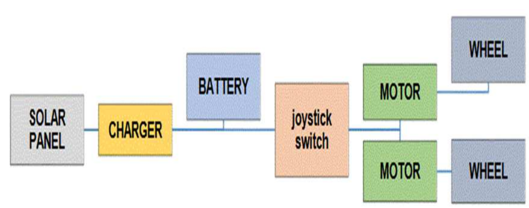
The diagram in Figure 1a shows the electrical circuit of the wheelchair in which the photovoltaic panel and the battery are connected in parallel with the help of an intermediate diode that prevents the reversal of energy. In the process of electric propulsion, the photovoltaic cell provides the energy of the controller that controls the motors on the wheels, depending on the direction and speed for which the user opts.

The solar wheelchair has three energy sources: the photovoltaic panel, the inverter and the battery. These are proposed in the solution of the final product, i.e. the prototype [2].

The diagram reports the path through which the controller transmits the command to the motor using the joystick (Figure 1b). At the same time, we can see how the power from the photovoltaic panel goes to the charger thus matching the excess energy to the battery. Battery is connected to potentiometer which helps to control the speed for the controlled movement of the solar powered wheelchair [8].



a. Prototype circuit of the wheelchair assisted by solar energy



b. Diagram of the operation block of the solar chair

Fig. 1. Details about the wheelchair design

Table 1

Wheelchair technical data.

Parameter	Value
Wheels type	4 equal wheels
Maximum seat speed	10 km/h
Supported weight	80 Kg
Maximum panel power (Pmax)	30 W
Volts at maximum power (Vmp)	18 V
Current load at maximum power (Imp)	1.67 A
Open circuit voltage (Voc)	21.24 V
Short circuit current (Isc)	1.83 A
Tolerance power panel	± 3%
Nominal Operating Cell Temp (NOCT)	45 °C
Maximum System Voltage	300 VDC
Operating Temperature	- 20 °C to + 60 °C
Protection Class	Class A
Cell Technology	Mono –Yes
Dimension	630 mm x 440 mm

During the design phase, the photovoltaic panel will have a fixed point on the roof of the chair composed of a metal frame and can be dismantled only in case of technical problems.

The photovoltaic panel is powered directly from the sun by the photovoltaic effect that converts energy into electricity with the help of the inverter. The solar wheelchair also has the possibility of folding and packing to be easily transported to other locations than the daily ones [17; 18]. The main factors that are considered for the assembly of the solar wheelchair are the weight, load, speed, width and height of the wheelchair. The wheelchair is built to withstand a load of up to 100 kg and the speed is limited to 5 km / h for user safety [1]. The height and width of the seat are slightly changed compared to the conventional model, i.e. the user can perform several maneuvers from this seat due to the adjustable solar frame [16].

The structure of the wheelchair contains the main frame, the steering mechanism, the power supply, the solar system, the wheels and other accessories [4]. The skeleton consists of several tubular rods, shaped to different lengths to be welded later, thus obtaining resistance to weight loading and vibration during movement.

The photovoltaic panel is attached to convert energy through the photovoltaic effect called the p-n junction [10]. The photovoltaic panel contains 36 cells and is slightly rotating on the structure, so that the solar radiation covers the total surface. When the voltage is low, the short-circuit current appears in the solar cell, to raise the voltage and supply the motor with the necessary energy, practically the system is continuously recalibrated [12]. For the correct distribution of electricity throughout, a controller will be attached to extract the available energy from the photovoltaic panel and sent to the battery. The controller also protects the discharge batteries at night [6].

The main advantage of the proposed solution is that the photovoltaic solar panel can produce energy even from diffused light, charging the batteries without problems. At the same time, another benefit of the solar frame is that it provides protection to the user both in summer and in winter [17].

The design of the wheelchair is provided with certain aspects of travel safety for the user, such as the belt, the armrests, the footrest and the adjustable seat. There will also be a module for charging the mobile phone, a fan with cold air in summer and an LED reading light [5].

The next step is to design the system level in which the product architecture is defined, and the parts are modeled in CATIA. Currently, the paper is in the design and simulation phase in a virtual environment. Towards the end, the prototype will be tested for a feasible model, through which it can start obtaining non-reimbursable funds through a social economy project [9]. The second step that makes the objective of the paper is to promote the idea among companies with a profile. The social economy supports a kind of social entrepreneurship through which you can develop services or products supported by non-reimbursable subsidies that can be delivered to disadvantaged people [12].

4. THE PROTOTYPE SOLUTION

The prototype (Figure 2) testing will be at low cost by implementing optimization techniques using improved design methodology.

Fig. 2. The propose solution of the solar wheelchair.

The seat is provided with a hand steering mechanism, as required. The whole body of the wheelchair has an aesthetic and futuristic look [3]. The solar frame can be adjusted as needed with the help of fasteners, so that the speed is limited so as not to create vibrations or other irregularities. A volume meter will be attached to check the battery charge level and speed so that the direction of the wheelchair is precisely controlled [3].

For user safety, the wheelchair is equipped with both horn and LED taillights for reading or lighting at night. The prototype wheelchair can be disassembled and folded for ease of storage and transport [17; 18].

The design of the chair also includes a medical element, for example the attachment of a switch that gives the user the opportunity to tilt the chair, so that the position can be changed whenever the person gets tired or has back pain. Tilted wheelchairs help reduce pressure [16]. The seat tilt system changes the weight load on the postural muscles and helps the circulation of the veins. The fact that the chair is also provided with the possibility of raising and lowering the level, allows the user to perform more activities in the household, but also at work [7].

This prototype (Figure 2) can be included in a social business model. In the thesis, there will be a dedicated chapter to obtain funding for the development of the prototype and its implementation. The proposal in the business plan of a social enterprise with a number of at least five people with disabilities who can develop the prototype of a solar chair, thus offering some goods that meet the needs of those who are in the same situation as them [4].

In Romania, at present there are no entities defined as social enterprises owned by disadvantaged people, which provide social goods or services to the economic environment. As this prototype must be included in a social economy business, it provides a plan for the integration of people with disabilities into society through specialized technologies, in this case the wheelchair [7]. With the help of the structure of the social economy, the perfect framework is created for people with disabilities to work in communiqués in the form of a job.

The objective of the social economy plan allows people with disabilities to carry out activities without major architectural changes. Through the concept of social economy the user receives the opportunity that the community offers. The social economy removes architectural and social barriers, which are sometimes placed in front of disadvantaged people [8].

The solution for the implementation of the wheelchair in a social economy project can ensure the transition to the labor market of people with disabilities. Thus, through a social economy plan, the prototype product can be promoted through which equal opportunities are obtained for all those who can benefit from this technology [7; 18].

The prototype developed in the social economy fully meets the needs of society. And in this context, society is more aware of the need to provide adequate support to people with disabilities [15].

5. CONCLUSIONS

The wheelchair can provide a maximum of 4 hours of continuous travel. Minimizing the charging time can be reduced by changing the capacity of the photovoltaic panel. The use of a wheelchair provides a reliable source of energy and reduces pollution. Ergonomic design meets the needs of the user through functionality and versatility [14].

The prototype is designed in the form of a social business plan to meet the standards of engineering, safety, environmental responsibility and user health. In the social economy project, if the concept of circular economy is applied correctly, competitive prices can be obtained for the raw materials for the assembly of the wheelchair, offering economic opportunities [11].

The seat will also be designed for the medical purpose of the passenger, to avoid any back pain during long-term use. In addition, the speed of the wheelchair is not high, so it will never cause injuries, even if it accidentally hits someone. This wheelchair is economical and affordable for ordinary people, for example low-income people [5].

The operating cost of this system is much lower compared to other systems used for the same purpose. The solar wheelchair is environmentally friendly, has no noise, does not pollute, offers a reliable and convenient travel tool for the travel of people with disabilities [7].

The solar wheelchair is a new technology for wheeled mobility with a social impact on the built environment and sustainable transport [1].

The design of the seat feed base includes active wheels both inside and outside, which allows the user to move and maneuver in limited spaces. The rear wheel drive position defines the basic handling feature of the solar wheelchair. Another important aspect of the seat's mobility circuit is the traction position of the rear wheels and the base of the front wheels, which support the beneficial center of gravity, especially when crossing a steep slope [15].

The speed can also be controlled electronically, but the direction is set manually. Dr. Alf Nachemson [1] has shown that tilting your back from 80 to 130 degrees can decrease the inter-vertebral pressure of the disc, but also the edema of the legs. Therefore, the wheelchair is secured by the position with a degree of inclination by means of a switch, which significantly reduces the static pressure of the seat and prevents the serious common problem of seat users, namely back pain and poor posture.

In conclusion, the technological development of solar wheel scanning represents the delivery of an efficient and comfortable product to people with disabilities, but also a sustainable business opportunity [8].

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Soluția unui scaun cu rotile cu panouri solare

Rezumat: Scaunul cu rotile este reprezintă la modul general, un instrument mobil vital pentru persoanele cu dizabilități. În circuitul pieței românești există doar scaune clasice (cu acțiune manuală) care sunt pasibile de producerea rănilor la membrele superioare și oboseală acută pentru utilizatori. Scaunele electronice care prezintă un risc mult mai mic de deteriorare a sistemului osteoarticular al membrelor superioare, sunt concepute pentru o manevrare mai eficientă, dar au un preț mai mare. In acest articol se prezintă procesul de proiectare și funcționare a unui scaun cu rotile utilizând propulsie electrică susținut de un sistem auxiliar, de alimentare cu energie solară. Sursa de energie solară poate crește raza de deplasare cu 26%, comparativ cu soluția care folosește o sursă de alimentare a bateriei (cu sistem de acționare electronică). Panoul solar al scaunului cu rotile va servi, ca protecție pentru utilizator împotriva factorilor externi, precum: radiații solare excesive sau precipitații (zăpadă, ploaie). Studiul cuprinde prezentarea dezvoltării economice a scanării roților solare prin conceptul de economie socială, anumite procese și activități ale fluxului tehnologic care pot fi efectuate de persoane cu dizabilități.

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