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Wheelchair with solar panels

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Abstract. *Manual wheelchairs offer a relatively inexpensive solution to the mobility needs of these people. Manual wheelchairs have a loss of gross mechanical efficiency and therefore the risk of user fatigue and upper limb injury is increased. The article presents a method of performing the quality function to develop a wheelchair with an auxiliary solar power supply system. The wheelchair has a modular design and can be disassembled and folded for ease of transport or storage. The proposed wheelchair provides an efficient and convenient way to meet the mobility needs of people with mobility difficulties. The research paper explains the design and manufacture of a solar wheelchair based on two aspects of engineering: the design of the electrical circuit and the mechanical assembly of the wheelchair. This research highlights the importance of the unconventional energy source, i.e. solar energy, and uses it to advance wheelchair technology. The prototype offers people with disabilities a user-friendly experience. The modular design of the wheelchair provided ease of transport and storage, thus overcoming the shortage of electrically operated wheelchairs. The research undertaking for the wheelchair with solar energy has grown considerably in recent years. All these factors will increase the demand and market for wheelchairs powered by solar energy***.***

Keywords: solar wheelchair, prototype, rehabilitation, ergonomics, smart city, social business, social enterprise, inclusion

Introduction

The wheelchair is an essential tool for mobility. On the commercial market we find chairs with manual or automatic operation (electric). Even more recently, the prototyping of wheelchairs powered by solar energy is being studied. By using the manual chair, the user gets tired repeatedly and can cause other health problems over time than existing ones. (Mason et al., 2013). 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 (Chien et al., 2014).

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. (Fehret et al., 2000). 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. (Yang et al., 2007).

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 (Kyocera,

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2013). 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 (Medola et al., 2014). 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 (Chien et al., 2014).

Methodology

The engine of the system (of the solar wheelchair) receives energy from the main source, ie from the solar-charged battery. The photovoltaic panel (solar panel) is positioned at the top of the seat, by means of an adjustable frame and collects solar energy with the help of photovoltaic cells transformed into electricity. When the solar system (photovoltaic panel) is exposed to the sun, it produces direct current and is stored in the battery (Fehret et al., 2000). The electricity produced by the solar panel needs a charge controller. The charge controller converts the fluctuating current and sets the process of constant power supply to the battery. The DC motor is connected to the two rear wheels by using the mechanical transmission arrangement. (Kyocera, 2013). The operating principle of the photovoltaic system is shown in Figure.1 and Fig.2 and represents the diagram of the solar circuit. (Karaghouli & Kazmerski, 2010).

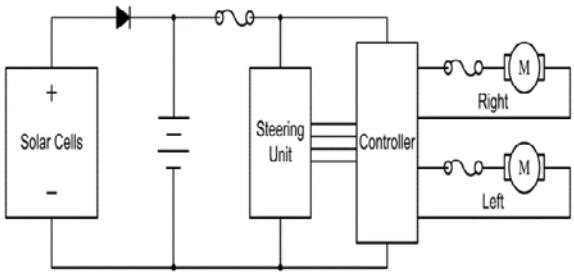

Figure no. 1 Circuit diagram of Current System

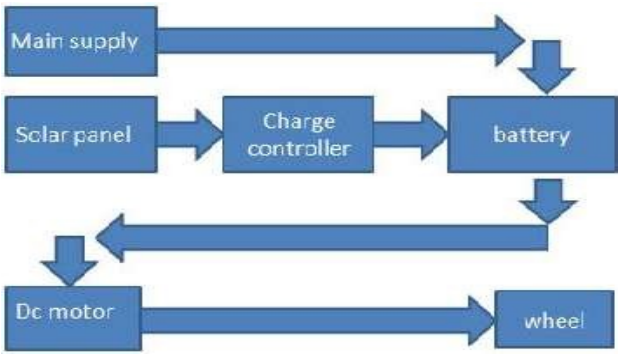

Figure no. 2 Block diagram of Working Principle of Current

There are millions of people in the world with physical and locomotor disabilities who cannot move at will. Thus, through this prototype we can change their lives using advanced technology. (Chien et al., 2014). The paper presents the design

methodology on solar photovoltaic efficiency that uses the advantages of photovoltaic orientation due to the latitude of the installation area. The design methodology allows the incorporation of a tracking mechanism with high availability and low costs. Based on the solar results, the final system can be mounted on the wheelchair. The proposed methodology is based on a diagram of the efficiency of the daily solar orientation. (Medola et al., 2014). The prototype must meet the following design criteria: low cost, low maintenance, high energy efficiency regarding solar energy collection and improved performance against wind action. The values of the specific parameters are presented in the table:

Table no 1. Solar tracker design parameters.

Design Parameters	Value
Latitude	27.5°
Efficiency as a function of the orientation (EFO)	95–100%
Maximum wind speed	33.3 m/s
Capacity	1 kW
Cost	Lowest available

The results of this methodology describe the solar tracking system on the trajectory of the sun for azimuthal tracking clockwise operating between 6:00 and 18:00 daily.

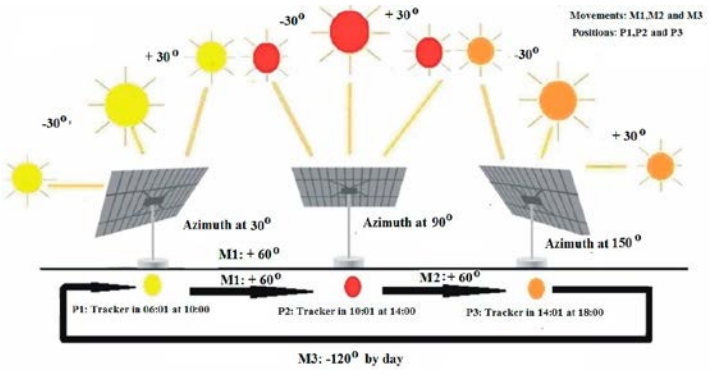

Figure no. 3 General operation of the solar tracker prototype

Throughout the methodology we find the step of selecting the mechanism in accordance with the necessary solar tracking capabilities. (Mason et al., 2013). They facilitate comparison matrices that facilitate the selection of the device on the structure and the development of the prototype. It also includes arithmetic calculations and CAD computer aided design elements. The design component for the solar panel has a support structure with wind resistance and azimuthal rotation as shown in figure 4.

Figure no. 4 Solar panel structure

The tracking mechanism is based on the matrix of the DC motor adapted to the mechanical transmission.

Mechanism	Cost	Availabiliy	Maintenance
Gear motor and linear actuator	L	H	M
Two slew drives	M	M	L
Two indexed motors	H	L	H

Table no.2 Actuator selection for mechanism tracking

The microcontroller determines the azimuth of the sun so that the solar panel rotates according to the desired angle. Once installed, the system measures the current I and the voltage U of the solar panel. These azimuthal values were chosen for summer and winter. (Yang et al., 2007). The three important components of the electric battery for the wheelchair, namely: capacity, current power and cell type. Capacity refers to the operating time of the battery and is accurate to amperes hours - Ah. The solar wheelchair works with 10 amps which is around 20 and 90 hours, which means that the seat can operate for up to 6 hours continuously. The current is given by the electric charge expressed in amperes A. The higher the amperes, the more the solar wheelchair will work without imbalances. Ecologically, batteries contain gel cells. (Gowran et al., 2014). The wheelchair consists of solar panel, voltage controller, DC battery source, DC motor, diode and glass fuse. Therefore the solar energy during the day is converted into electricity. This solar energy is stored in the gel cell battery in the form of electrochemical energy. During the power transfer from the panel to the battery we can use the diode to avoid discharging the battery from the panel at night. When the battery is fully charged, then the voltage converter is used to control the motor speed. (Mason et al., 2013). The microcontroller determines the azimuth of the sun so that the solar panel rotates according to the desired angle. Once installed, the system measures the current I and the voltage U of the solar panel. These azimuthal values were chosen for summer and winter. (Karaghouli & Kazmerski, 2010).

In the design process of the prototype are also found the brakes as an essential part of the system. It works when the lever is pulled, the brakes are connected to the controller and when it is pulled, and it generates current and stops the wheel from moving. (Messenger, 2010). The system is also designed with a headlamp that can illuminate the darkness, and is useful at night for people with disabilities to move from one place to another.

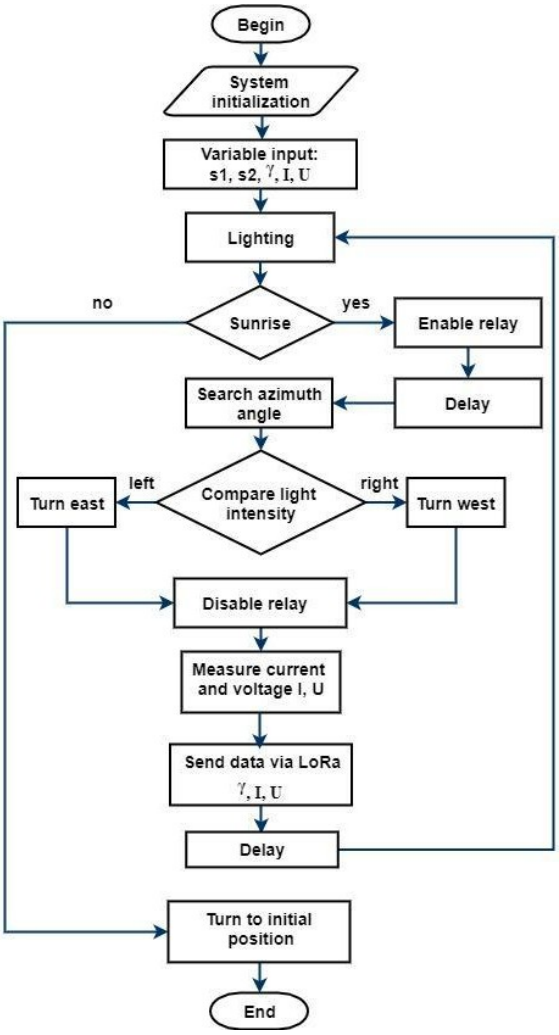

Figure no. 5 Algorithm for a single-axis solar tracker based on photosensors.

Conclusion

The prototype of the proposed wheelchair brings many benefits for users, both for external and internal operation. The design of the solar wheelchair is a blessing for people with disabilities and will bring a major change in their lifestyle. Prototyping is done with equipment and parts at low cost using the concept of circular economy. This solar wheelchair breaks down the social barriers in the current system, thus increasing daily comfort. This project involves electronic circuit, design and green knowledge. (Arvind et al., 2013). The design of the wheelchair is sustainable. Also, the solar wheelchair supports movement in almost all stairs specially designed for people with disabilities that we find in institutions, offices, industries and also in some homes. The design is made in a safe format and there is no chance of damage to the frame and wheels in their use under normal conditions. (Chien et al., 2014). 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. (Yang et al., 2007). Mobility is a fundamental right, and people have the right to have a wheelchair. For many who cannot walk independently, a solar

wheelchair provides mobility. With a solar wheelchair you can exercise your freedom of movement. Independent mobility can make it possible to study, work, and participate in cultural life and access to healthcare, leading to equal inclusion and participation. (Fehret et al., 2000).

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