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Manufacture of solar wheelchairusing waste materials: applied in Bechar-Algeria

Nadjat Dahmani [1] * and Mebarka Daoudi [2] †

[1] Science of Matter Department, Faculty of Exact Sciences
University of Bechar, P.O.B 417, 08000 Bechar, Algeria
[2] Laboratory of Semiconductor Devices Physics, LPDS
University of Bechar, P.O.B 417, 08000 Bechar, Algeria

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Abstract - *Mobility is a fundamental right for all and is essential to the social contacts and communication of every individual. The wheelchair is one of the most common technique use to improve mobility of person with reduced mobility, it helps them to become more productive members in their communities. These wheelchairs are usually recharged via the standard power grid where they require two rechargeable batteries of 12 volts***.***The main idea of this work is to create a wheelchair totally powered by solar energy using a photovoltaic system in order to charge the batteries and extends the autonomy of the wheelchair.*

Résumé - *La mobilité est un droit fondamental pour tous et est essentielle aux contacts sociaux et à la communication de chaque individu. Le fauteuil roulant est l'une des techniques les plus couramment utilisées pour améliorer la mobilité des personnes à mobilité réduite, il les aide à devenir des membres plus productifs dans leurs communautés. Ces fauteuils roulants sont généralement rechargés via le réseau électrique standard où ils nécessitent deux batteries rechargeables de 12 volts, l'idée principale de ce travail est de créer un fauteuil roulant totalement alimenté par l'énergie solaire en utilisant un système photovoltaïque afin de charger les batteries et de prolonger l'autonomie du fauteuil roulant.*

Keywords: People with reduced mobility - Wheelchair - Solar energy - Photovoltaic system.

1. INTRODUCTION

In order to make the development of our civilization sustainable and cause less harm to our environment, we are looking for new source of substitute clean energy: solar energy. German Space Agency considered Algeria as the largest solar potential of the entire Mediterranean basin, by 169.000 TWh/year for solar thermal and 13.9 TWh/year solar photovoltaic [1].

Where the duration of sunshine in the Algerian Sahara is about 3500 h/year, which is always greater than a 8h/day and can reach up to 12 h/day during the summer as figure 1 indicate [2].

Nowadays, solar energy is in the process to become the major source of electricity in the world and in order to product electricity from this inexhaustible energy, it is necessary to use a photovoltaic system. In this work, we study the photovoltaic system for powering a wheelchair using by people with reduced mobility.

Mobility is a fundamental right for all and is essential to the social contacts of every individual. The wheelchair is one of the most commonly used technical aids to improve

* dahmani.nadjat49@gmail.com
† mebarkadaoudi@yahoo.fr

mobility for people with reduced mobility in order to become more productive members of their communities.

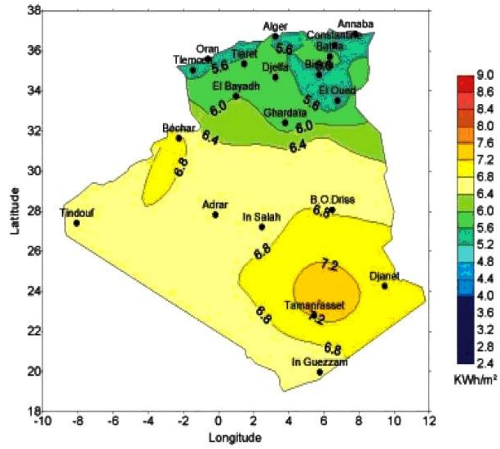

Fig. 1: Solar potential of Algeria

In general, People who travel using electric wheelchairs usually recharge their chairvia the standard grid, where, each wheelchair requires two rechargeable batteries of 12 volts. The idea of the study is to realize a wheelchair powered totally by solar energy using photovoltaic (PV) system.

PV system is a complete set of photovoltaic equipment to transform sunlight into electricity; usually it consists of five main elements [3]: photovoltaic generator (solar panel), regulators, batteries, converters / inverters (case connection to the grid) and the load (here the wheelchair). To power the wheelchair we chose the system as shown in figure 2**(a)**.

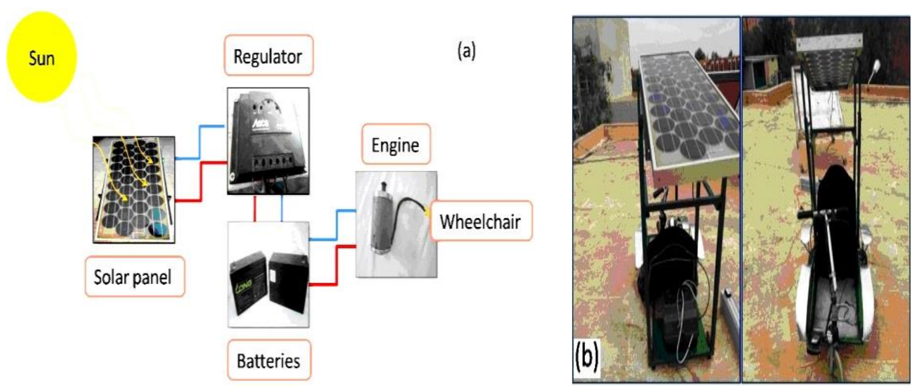

Fig. 2: Diagram of the wheelchair: **(a)** photovoltaic system for powering the wheelchair, **(b)** prototype of the solar wheelchair

A photovoltaic installation on the wheelchair was used to allow people with reduced mobility to gain more autonomy in order to more freely understand certain daily tasks of their life and become independent of the public electricity grid [4]. It is the important stage in building of the solar wheelchair after building the structure which has made from the recycle materials, choose the solar panel that fits the size of the chair and the engine's capacity to move it and place it above at a 32 ° angle where it represents the latitude of Bechar city (figure 2**(b)**) [5].

Then came the trial and operation phase, where we tested the solar wheelchair at different weights and speeds in different roads. After all parts were ready for operation and experimentation, we first started the processing phase, which included the manufacture of the control circuit in the speed of the electric engine as figure 3 shown.

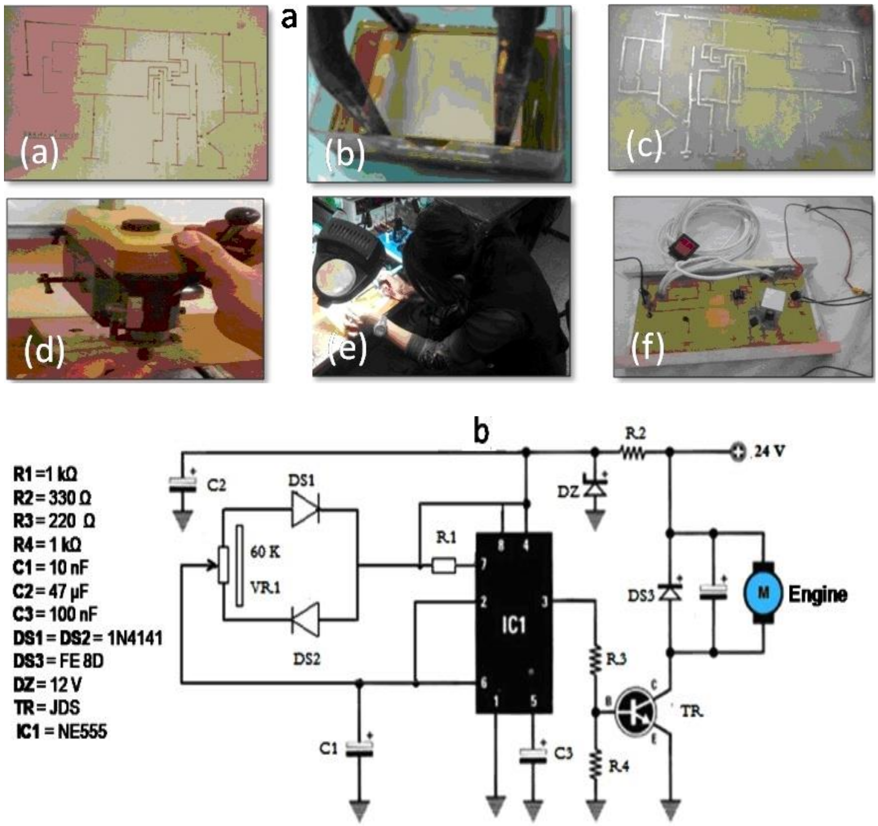

Fig. 3: Engine's circuit of the solar wheelchair
(a) experimental elaboration, **(b)** circuit shame

The preparation of the engine's circuit follows these steps,

a. Drawing the electrical circuit on the burner with the pen and a special program on the computer can also be used. Transfer the design standards drawing circuit into a copper plate measuring the required circuit.
b. We immerse the plate in the chemical detector and move it.
c. We washed it with water to remove the traces of the chemical reagent.
d. We placed the plate in the drilling machine containing the iron which removes the unwanted copper shell in order to get the final shape.
e. Put each component in place.

Thus we obtained a printed circuit with all its components represented in Fig. 3.

To provide the solar wheelchair it is necessary to connect the global properties of the solar wheelchair as presenting in **Table 1**.

As stated previously, the wheelchair is based on the frame of a wheelchair and has a weight of 95 kg. The auxiliary components of the wheelchair, e.g., the solar panels, regulator and batteries set have a combined weight of 15 kg. Thus, the wheelchair has a total weight of approximately 140 kg.

Table 1. Technical characteristics of the electric wheelchair

Parameters	Value	Unit
Wheelchair weight	1.08/0.58/1.1	m
Wheelchair weight	95	kg
Battery weight	5	kg
Person weight	62	kg
Panel weight	8	kg
Total weight	140	kg
Time moving	5	S
Velocity	5	
Voltage on the battery	12	V
Current of the engine	10	A

2. THEORETICAL MODEL

To operate the wheelchair with a solar panel, we need to know the forces applied to the wheelchair. To know these features, the second law of Newton must be applied [6].

The total mass (M_t) is given by,

$$M_t = Mp + M_f + M_{pa} \quad (1)$$

The force (F) required pushing the wheelchair on a flat surface is given by equation (2),

$$F = \frac{M_t \nu}{t} \quad (2)$$

for the case when the road is tilt F becomes,

$$F = M_t g \sin\alpha \quad (3)$$

When the friction effect exists, he force necessary to move the wheelchair is given by following relation,

$$F_t = \mu F \quad (4)$$

The power force (P) is given by,

$$P = F_t \nu \quad (5)$$

where M_p is the person mass (kg); M_f is the wheelchair Block mass (kg); M_{pa} is the solar panel mass (kg); v_{is} speed of wheelchair (m/s); t is initial time to move the weelchair (s); α_{is} the slope angle (degrees) and μ_{is} the friction coefficient.

3. RESULTS AND DISCUSSION

Bechar city is located in the South-West Algeria which is described geographically by latitude 31.616 °N and longitude 2.15 ° W [7] as figure 4 shown.

The study was realized in the 29th May, 2018 where the Sun risesat 6:40 and sets at 19:38 which are presenting an average of 12 hours and the temperature is 34 °C. When sufficient sun light is available, the solar panel on the wheelchair roof is used, and when it is limited, the batteries are used.

The final prototype is shown in figure 4, which can successfully carry a disabled person and can move freely without any human assistance. The solar wheelchair works remarkably within expectations.

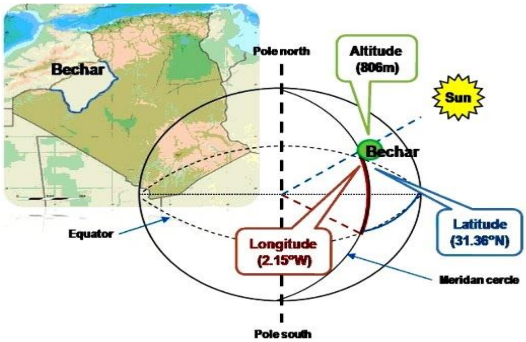

Fig. 4: Bechar city geographic localization

The major tests of the proposed solar wheelchair are briefly described in the **Table 2**, where, solar radiation, wind velocity and the humidity are about 819.7 W/m^2, 9.2 km/h and 26 % respectively.

A wheelchair must meet the requirements of its user as well as the conditions of its environment, must provide postural support, total safety and be resistant. **Table 2** and figure 3 indicated these requirements.

Figure 2 and figure 4 present engine's circuit and a photograph of the final prototype wheelchair. The basic specification details of the wheelchair are provided in **Table 1**.

Table 2. Experimental condition and results in the 29th May, 2018 (T = 34 °C)

Quality road		Angle slope	Velocity, m/s	Time, s	Distance, m
Puzzled	Flat dry	/	1	8	6
	Tilt dry	5	1.33	6	
	Flat wet	/	1.33	6	8
	Tilt	9.4	1.6	5	
5	Flat sandy	/	0.5	16	

The testing experience of the solar wheelchair was realized behind the research laboratories building at University of Bechar where we have fixed the distance at 8m as a reference distance for all of testing cases then measure the time taken.

Figure 5**(a)** represents the case of the flat road; we remarked that the solar wheelchair moved easily all the distance mentioned above in period of time was 8s.

Figure 5**(b)** and Figure 4**(d)** present two cases of the road dry-tilted, sloping road and dry-tilted, pitched respectively. The chair moved easily in a distance of 8 m for a period of time less than 8 seconds obtained in the first case where the tilt angle of the road is estimated at 5 ° either way the second case is estimated at 9.4 °.

In figure 5**(c)** the solar wheelchair was tested in wet road, in this case the water depth was 0.02 m. in these conditions, the chair moved normally.

In contrast, in the sandy road presents in figure 5**(e)**, we noticed that the chair has found difficulty to move due to the road friction coefficient and the wheels size.

Figure 5**(f)** describes the case of the shadow effect on the solar wheelchair. In this case the chair moves after a moment, we think that the batteries take the responsibility of moving the chair.

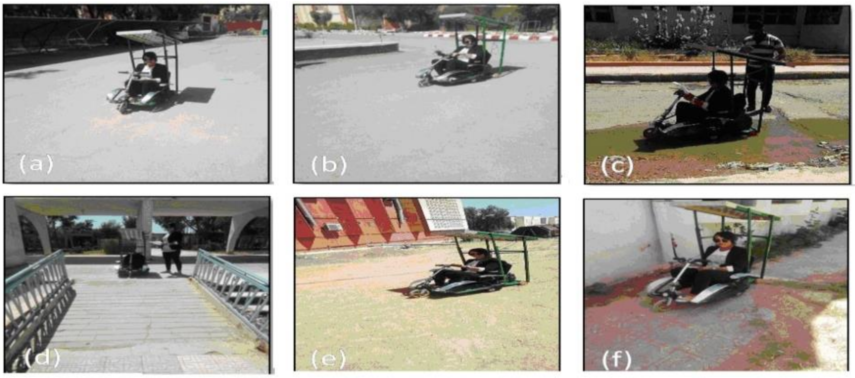

Fig. 5: Different cases of solar wheelchair testing

4. CONCLUSION

We have discussed in detail in this paper all steps of the experience of our solar wheelchair. The present work involves in design and fabrication of solar wheelchair. A motorized solar wheelchair is propelled by a solar electric motor.

This type of chair can also be used not just by people with *traditional reduced mobility*, but also by people with cardiovascular and fatigue based conditions.

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