RESEARCH ARTICLE

RSP Science Hub

International Research Journal on Advanced Science Hub
2582-4376
Vol. 04, Issue 06 June
www.rspsciencehub.com

Check for updates

http://dx.doi.org/10.47392/irjash.2022.043

Energy opportunities for delivery robot during Disaster

Muniyandy Elangovan[1], *Mohammed Nayeem*[2], *Mohamed Yousuf*[2], *Mohamed Nauman*[2]

[1]*Professor, Department of Mechanical Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, No.42, Avadi-Vel Tech Road, Vel Nagar, Avadi, Chennai, 600062, Tamil Nadu, India*

[2]*Department of Mechanical Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, No.42, Avadi-Vel Tech Road, Vel Nagar, Avadi, Chennai, 600062, India*

Emails: muniyandy.e@gmail.com, nayeemrafi786@gmail.com, yousuf07062001@gmail.com, c.md.nauman786@gmail.com

Article History

Received: 25 April 2022
Accepted: 20 June 2022

Keywords:

solar panel;
disaster management;
energy sources;
flywheel energy;
a delivery robot

Abstract

The robot is being used in many applications for a different domain. The delivery robot was developed, and the battery was placed for the power source. Considering the abnormal condition/situation during the disaster period, energy is a critical issue for the robot. To overcome this condition, three kinds of power sources were identified such as (i) direct energy, (ii) solar energy and (iii) flywheel storage energy. All three power systems were designed and found that the delivery robot can be operated without any interruption with these power sources. The Flywheel energy storage system was fabricated and tested with the delivery robot. With these identified energy sources, it is possible to operate the delivery robot without any external supply. It can help in any disaster situation to do services to people using the delivery robot.

1. Introduction

Delivery robots are used to move freely around a physical space without being guided by humans. We aim to develop an autonomous delivery mobile robot that can deliver a package autonomously from A to B within the location. The robot is designed to operate as an independent mobile platform for different applications. Autonomous delivery robots decrease the need for large, possibly polluting trucks to travel around congested cities and the number of delivery drivers needed to deliver people's online orders swiftly.

The robot is designed to operate for two or three hours because of the size and power limitation of the battery. Therefore, the battery is used through the swapping method to manage the robot for the entire day. Presently, AC charges are used to charge the battery. It cannot run for 24 hours during a disaster because AC supply might not be available. So, to solve this case, with an idea of external power generation for the delivery robot with the help of solar energy and a flywheel for effectively generating power to the delivery robot.

In India and other parts of the world, solar is regarded as the cleanest and most abundant energy source. This energy can be used when converted to electrical energy using semiconductors in the form of photovoltaic (PV) cells or solar panels (Venkatakrishnan and Rengaraj). Solar energy systems are now readily available for industrial and home use, with the added benefit of minor maintenance. (S. P. S. P. Srivastava and Srivastava). Solar energy is converted to electrical energy using the electric-generation principle of solar panels: the voltage converter circuit and filter circuit store electrical energy in the energy storage battery. The conversion of solar energy to electrical energy is accomplished through emergency power. It also recognises the quick and safe charging of energy storage batteries. (Wang). Keeping the boards aligned with the sun will maximise power output from the solar panels. As a result, a way to track the sun is necessary. Rather than purchasing extra solar panels, this is a significantly more cost-effective option. The yield (Vinaya and N) has been calculated. This cell technology is utilised to create low-cost, high-conversion-efficiency solar cells. When the cell receives photons from the sun, electrons are pushed loose from silicon atoms and dragged away by a grid of metal conductors, which forces a direct electric current flow (Khan and Arafat). It offers several benefits, including being pollution-free, having a long lifespan, and requiring little care. Solar energy is the most abundant form of energy that can meet the needs of communities as a result of long-term economic growth (Das et al.). Robotic delivery has the potential to provide value to our communities, yet, technological engineers are still ironing out the wrinkles. These Personal Delivery Devices can tackle many of our city's problems (Harjanti et al.). The popularity of Sidewalk Automated (or Autonomous) Delivery Robots (SADRs) is expanding. SADRs are human-sized robots that deliver packages to customers without the assistance of a human (Kalogirou). This project seeks to recover the energy from the flywheel using the energy recovery system principle and produce enough energy to run the project setup and some extra energy to run the external power supply (Amirruddin et al.). The exciting thing about this arrangement is that the alternator's output can provide more electrical output power than appears to be pulled from the input motor. Flywheel is used to accomplish this. The gear train is linked with the gravity wheel or flywheel to produce excess energy or free energy (Bade, Bharambe, and Joshi). Flywheel Energy Storage is a novel concept for dealing with the challenges of inconsistent energy supply. An FES system is a self-contained battery that does not generate power. The kinetic energy is converted and stored. The flywheel revolves in a magnetically levitated, frictionless environment with minimal energy loss over time (Wong et al.). This project aims to recover energy from the wheel using the flywheel's energy recovery system and produce enough energy to run the project setup and some extra points to run the external power supply (Hyder, Sudhakar, and Mamat Alghoul et al. Tan and Hui Oo, Lwin, and Hlaing).

2. Delivery Robot

The delivery robot is used to deliver products from one point to another. It is used in many appliances such as food, groceries, hospitals and many industries. It is pollution-free. It can detect the obstacle, and it can resolve itself. The delivery robot can be commercialisation which has potential for future business. The detail of the delivery robot ad control systems is shown in Figures 1 & 2.

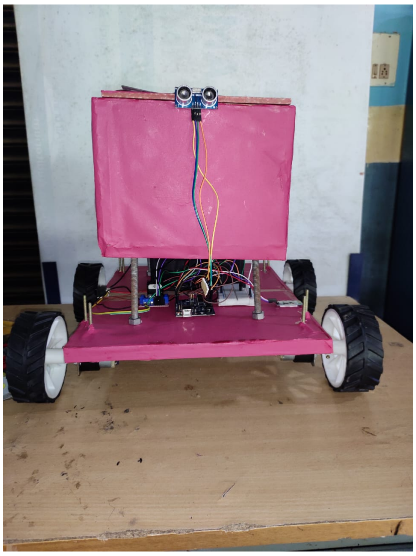

FIGURE 1. **Developed Delivery Robot**

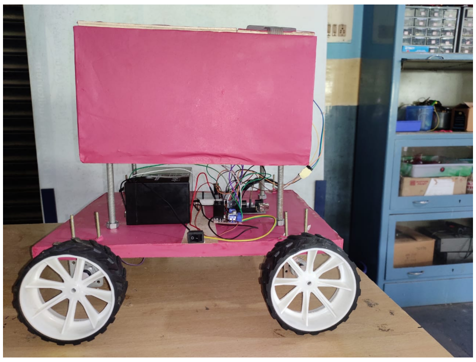

FIGURE 2. **Delivery Robot Control System**

3. Robot Energy Opportunities

The domain of Robotics is a good partner of renewable energy and is becoming critical to the sustainability and survival of the energy industry. The application of robots and automation saves time, increases productivity, & optimise performance. It

TABLE 1. Power Calculation for Robot

Item	Volt	Current	Watt	Qty	Total in W
Motor	12	0.3	3.6	4	14.40
Uno	9	0.2	1.8	1	01.80
Bluetooth	3.3	0.05	0.165	1	00.17
Sensor	5	0.01	0.05	1	00.05
		Total	Required	Power	16.42
Battery (Placed in Robot)	12	7.2	86.4	1	86.40
	Total	Running	Hours	Using Battery	05.30

TABLE 2. Power from Robot Surface

Sr. No	Area	Solar Panel Volt	Total Volt
1	52 cm^2 x 1 side	6v	6V
2	55.25 cm^2 x2 side	6v	12V
3	213.5 cm^2 x side	9v	18V
		Total Volt Produced	36V

TABLE 3. Power from Each Cell

Items	Cells	Volt Produced
1	24	12

TABLE 4. Total Power from Panels

Items	AMPS	Quantity	Total
Small solar panel	0.1	3	0.3
Big solar panel	0.33	2	0.66

TABLE 5. Estimation of Charing Hours

Battery	Panel	Charging Hours
7.2 mAh	0.96 mAh	7.5

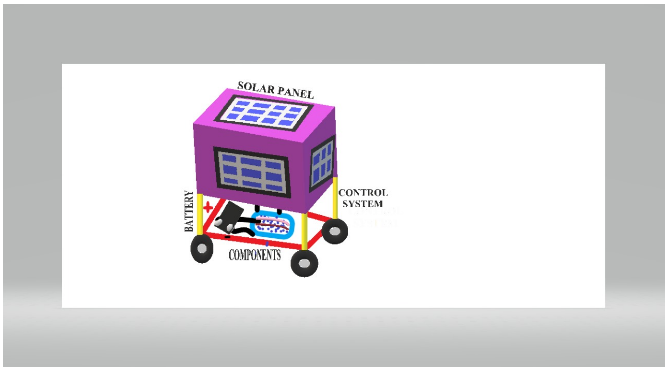

FIGURE 3. Solar Panel fitted Over Robot

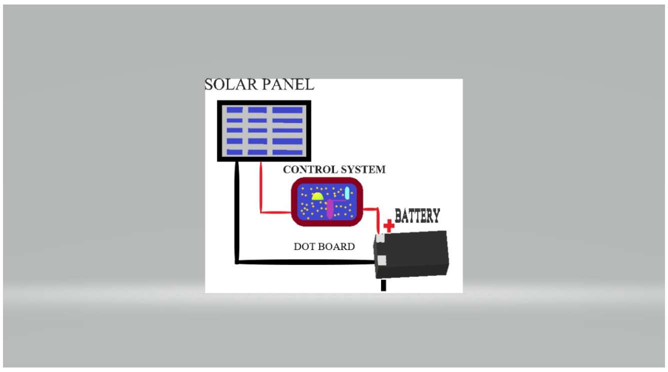

FIGURE 4. Charging of Battery through Solar Panel

is described that energy is inexhaustible and is constantly being recycled. Solar cells are integrated into the robot's chassis, and power is generated for the robot through the photovoltaic effect. By doing analysis and power calculations, we came up with three methods. They are:

3.1. Direct Energy

In this energy generation method, the energy is directly stored in the battery using a solar panel. The

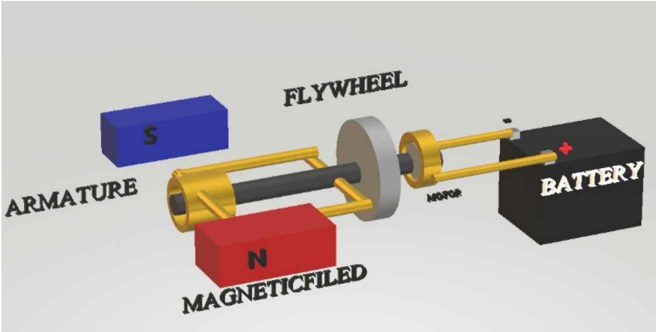

FIGURE 5. **Flywheel Charger for Robot Battery**

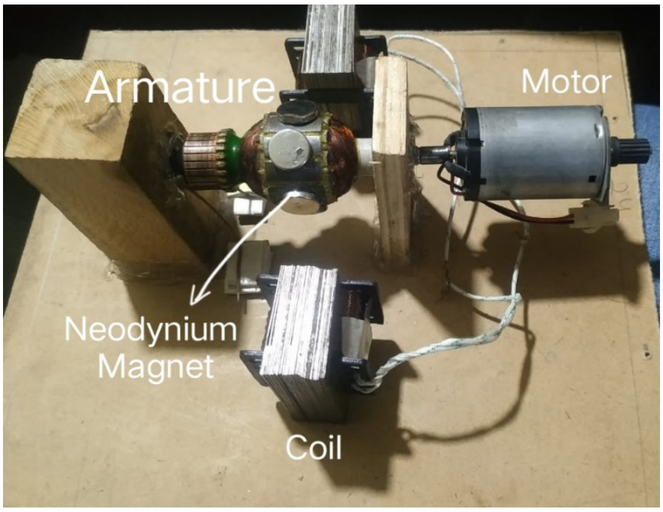

FIGURE 6. **Power Generation Setup from Magnetic System**

solar panel is connected to the battery with the help of a controller. Solar panels comprise photovoltaic cells that react to UV rays and transform them into electricity. Each cell consists of conduction materials from silicon, which is highly reactive to solar energy. Here the sunlight hits the solar panel and creates an electric field. The electricity generated flows to the board's edge and into a conductive wire. The conductive wire is connected to the controller. And the electricity is stored in the battery which we can use in a disaster. This concept is shown in figure 3.

3.2. Solar Panel to the Delivery Robot

The solar panel is fabricated and attached to the delivery robot in this energy generation method. Solar cells are integrated into the robot's chassis, and power is generated for the robot through the photovoltaic effect. This power is used in disaster or crisis times, where continuous power is impossible. Here the solar panels are attached on all the sides of the delivery robot. Although 100% power cannot be used, there will be some power loss because the sunlight does not hit on all the panels. So, the 50% energy will be received and stored there will be continuous power held in the battery so afterwards it can be used in needed times. The schematic arrangement for charging the robot battery using the fitted solar panel is shown in figure 4.

3.3. Flywheel Energy to generate electricity

In this energy generation method, the power is generated by the flywheel. Electric motors are used to accelerate the rotation of the flywheel in flywheel energy storage. Electrical energy is converted to mechanical energy and stored in the battery. The components are Armature, flywheel, copper wires with c shaped metal support and neodymium magnets. The armature is fixed at a place with the help, and the neodymium magnets are placed around it. And the copper is placed around the armature. Due to electromagnet induction, the armature rotates, and the flywheel connected to the end of it rotates, and the current will be produced. The current will be stored in the battery. Figures 5 and 6 show the setup for power generation to the robot.

4. Power Generation Estimation

4.1. Delivery Robot Power Consumption Estimation

Power estimation for the entire robot operated is estimated and it is shown in table 1.

4.2. Delivery Robot Power Generation

In the Solar panel is attached all five sides of the delivery robot. To optimize the total efficiency of the solar panel. A control system is placed to avoid mall function or overload during charge.

Top View: The upper view of the delivery robot its area is 52 cm^2

Side View: The side view of the delivery robot its area is 55.25 cm^2

Back View: The back view of the delivery robot its area is 213.5 cm^2

The table-2 shows their area and volt for the delivery robot:

4.3. Solar Panel Calculation

Power estimation for the solar panel cell, possible power for the available panel and the charging hours are calculated which are shown in Table 3 -5.,

5. Conclusion

Three sources were designed and estimated for the operation of the delivery robot without interruption due to the power supply. Direct Energy and solar energy were calculated, and schematic sketches were developed. The entire setup is being fabricated and tested for electrical power for the flywheel storage energy. Presently, the flywheel energy gives less power. This needs to be improved by proper design of armature and coil. It is concluded that the robot's present energy storage system can be operated continuously without any interruption.

ORCID iDs

Muniyandy Elangovan https://orcid.org/0000-0003-2349-3701

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Embargo period: The article has no embargo period.

To cite this Article: Elangovan, Muniyandy, Mohammed Nayeem, Mohamed Yousuf, and Mohamed Nauman. "**Energy opportunities for delivery robot during Disaster**." International Research Journal on Advanced Science Hub 04.06 June (2022): 180–185. http://dx.doi.org/10.47392/irjash.2022.043