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Research paper

Design and Fabrication of Garbage Collector on the Beach Using Solar Power

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Abstract

Beach sand cleaning is one of the most needed aspects that have to be implemented for clean future. Even though many organizations are involved in removing the debris the amount of debris keeps on increasing day by day. From the various studies related to this paper, we found that a general awareness is created for the public regarding the environmental pollution and also machines are created with a complication in design and lack of efficiency. So, we have come up with a machine which is capable of collecting the garbage's from the beach and that too with the simple design. Here the beach sand is cleaned by some mechanical equipment like conveyor, motor, gears which gives a fine outcome of the result. The Solar power is the main source of energy used in this machine. A 50 Watts monocrystalline solar panel is used for better results. The power from panel stores in a 24-volt 14 amps Lithium-Ion battery which then moves on to the motor which runs the conveyor and the machine.

Keywords: *Garbage collector; solar power; hybrid garbage collector; beach garbage collector;*

1. Introduction

Deposition of waste is a major problem in the world due to the increase in population. Especially materials like plastics deposition are a big threat to the environment since they take more time to decay comparing with other degradable materials. Comparing to the urban places, plastics that are being thrown on the coasts of beaches increases the plastic garbage level. This causes land pollution and also harmful to the environment and us. Due to this, the fertility of the sand on the coast is reducing and thereby causes the soil pollution as well as land pollution. This affects the nature and causes various problems. While the preservance in the atmosphere may cause detriment, which precariously affects living things and pollutes the environment (air, water and soil) which causes hazardous effects. Every year, roughly eight million tonnes of plastic garbage which is deposited on the beaches is mixed into the ocean. Despite this constant polluting plastics, plastic bottles, and beads many bits of which wind up washing back to shore. Some beaches didn't look quite trashy enough. Plastic is overall used in the world heavily due to the versatile nature, less weight, flexibleness, resistant to moisture, strength to weight ratio, and relatively inexpensive. The traits which made it direct overall atmosphere, which slowly creates such a large craving and heavy usage of polymer and materials made of plastics. Durable property and slower degradation of plastic materials which were plays major role in plastic products all over the world. Our tremendous use of plastic, with unquestionable deeds, increase in munch through, dumping, trashing and in so doing, polluting due to less space available for dumping, turn out to be an amalgamation of the deadly environment. The dangerous effects of garbage on marine ecosystems are well known from aquatic animals and other coastal animals swallowing plastics and other metals.

Plastic pellets commonly known as nurdles, that has a diameter of 5mm. Pellets are used as raw material to manufacture plastics. These pellets get spread through the environment. It serves as one of the main providers of debris found in the coast. Out of the total debris on the beach 98 %of, the contaminant is nurdles.

2. Components

Effectiveness and flexibility of the mechanical system is the first thing to consider while selecting a component. This low-cost mechanism needs small time for the design and manufacture and fabrication. We are making the garbage collection equipment that is working on solar. The main aim is to introduce the use of non-conventional energy source to run the mechanical machines rake is well known to all for its application. It is a material handling equipment basically used to the wheel, moves, rotates & places the wastes, which was extracted by the motion of the conveyor. The constructional parts used for this machine are very simple and readily available. Components of the vehicle are as follows:

2.1 Frame Design

The frame is the mechanical member which acts as a skeleton that holds the total structure of the vehicle. The frame is rigid and also

withstands the static and dynamic forces, without undergoing deformation or distortion. Frames of all automobiles differ based on the load, speed, and torque and engine transmission. It may be reinforced with super materials as per the requirement.

2.2 Spur Gears

To transmit power from the drive spur gears are used. Also, they help in reduction of speed and increase in torque. Since power drive transmits the power that is running at high speed it is needed to lower the speed level to the safe level. Gears mate when the module of one gear matches with another gear. The module can be calculated from the ratio of diameter to the number of teeth. Due to the high efficiency, here gear drives are used.

2.3 Conveyor

The conveyor is a mechanical transmission device that is used to transmit materials, goods from one place to another over a mid-range distance in a stable position. They involve in the movement of materials in a vertical position, or inclined position, or at an elevated angle. Conveyor chains are used for longer distances and at low speeds. Rake is the frame like part which holds the weight of the transmitting object over the belt. Product design is now not confined to few creative artists, can be learned by systematic study. Fortier stress was laid on design as a synthesis of stress analysis, theory of mechanism and machines and another subject like machine design and dynamics of machinery. But current approach is to expose the student is uncovered to solve a real problem with various optimization tools. Here to transfer the garbage the conveyors are used. Conveyors are set in a way such that the garbage is made to fall over it. Then the garbage which is fallen is safely stored in the container as they directly deposit over it. Based on the size of the container the storage level may vary.

Fig 1:- 3D model of conveyor and drive

2.4 Trash box:

The neat dust collection is the main part of the machine & project. In the machine, the dust is collected in dustbin which is placed or attached in the frame. The dustbin is a removable part of machine means when the dustbin is full of dust or particles we can remove it and again place it

2.5 DC motor:

We use two DC motors in this machine one is the gear motor and the other one is the high-speed motor. The gear motor is used is run the conveyor chain. The special feature of gear motor is to induce high torque. As per the calculations made from the design we use 50 Watts gear motor and the other motor has a capacity of 10 Watts to run the wheels of the machine to move forward. Cranes use gear motors that which works based on Flemmings rule. Here speed is compensated to increase torque since they are inversely proportional. The speed required by the conveyor can be calculated and based on that speed, a gearbox has to be placed. The gearbox increases the speed by decreasing the torque and vice versa. Speed conversion takes place through different gears and shafts at different stages as required.

2.6 Battery:

The battery is an electrical device used to store electrical energy for a certain period of time. It has two power terminals called anode and cathode. The chemical reactions take place in the battery produces electrons which are moved along the circuit thereby produces electrical energy. Here lithium-ion battery is used as power source, due to its transportability, less weight, and long storage capacity compared to its size. Also, the power produced by the solar panel varies with time, and in order to store the varying energy lithium-ion batteries are suitable.

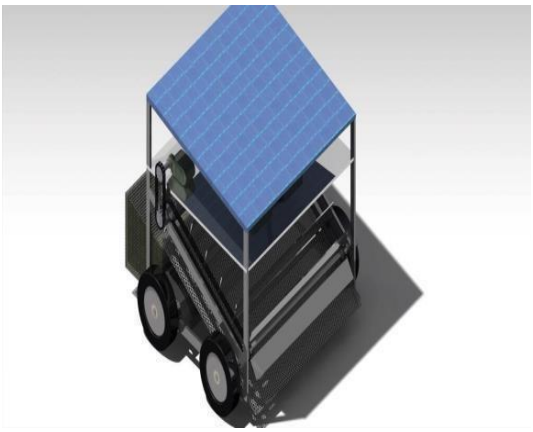

Fig 2: Garbage collector Modelled using CATIA

3.Design Calculations

Battery size and capacity:
Amps * Volts = Watts 14A*24V = 336 watts
The Power consumption for the motor used for the conveyor is 50 watts. The Power consumption for the motor used for wheels is 10 watts. So, the total power consumption will be 60 watts and the machine is to run 3 hours per day.
60 w * 3 hrs per day = 180 watts
In summer days we will get an 8 hours sunshine whereas in the winter days we will receive the sunshine only for 5 hours.
In summer days
Watts required / time in the sunshine
Hours = 180/8 = 22.5 watts
In winter days
Watts required / time in the sunshine
Hours = 180/5 = 35 Watts
In order to reduce the charging hours, we take the watts approximately as 50 Watts because we are going to operate the machine only for 3 hours. Charging hours for the battery from the Solar Panel is about 3.5 hours.
Belt speed:
D = Diameter of the sprocket
S= Diameter x Rpm x 0.2618 x 1.021
= 2 x 20 x 0.2618 x 1.021
= 10.5 (or) 11 rpm
Belt load:
P= Product weight of the chain C= Centre distance (feet)
G = Load per square feet (lbs) W = Weight of the belt
P= G1 x C x W = 8 x 1.5 x 4 = 213.6N
Effective tension:
Force required to move the belt E = F (P+M)
E= 30 x (48+15) E= 85N
Slack side tension:
To avoid slip on driving pulley E1= ExK
E1= 85 x 0.8 E1= 70.31 N

Tight side tension:
Overall tension required to move the belt over both the pulleys and load E2 = E + E1
E2 = 85+ 70.31 = 155.31 N
Operating tension:
Belt strength required inorder to withstand the required loadT = E2 / W, T = 155.31 / 4 T = 38.4 N
DC Gear motor:
Acceleration a = velocity/time =1/8m/s^2
a = 0.125 m/s^2 Fu = Peripheral Force (N)
Fu = m.g + m.a = 50x9.81 + 50x0.125 Fu = 497 N

T = Torque (Nm)
T = Fu. D/2000 = 497x50/2000 T = 13 Nm
n2 = Gearbox Output rpm (rpm) n2 = ν /d • π (60000)
= 0.125/50x π x (60000), n2 = 45 rpm

i = Gear Ratios n1 = Gearbox input rpm (rpm) i = n1/n2
1.5 = n1/45
n1 = 68 rpm P = power of the motor
P = T x n2/9550 x η = 13 x 45/9550 x 0.90 = 0.06Kw
The value is taken out from the specification of TG-77 24-V DC gear motor

4. Working

When the machine is switched on, the power from the battery reaches the motor. There are two motors kept on this machine. One motor is used for rotating the wheels while the other motor is used for the rotation of conveyor. When the motors receive power, the motor assigned to the wheels starts its work by moving the wheels forward. At the same time, the motor assigned for conveyor does its work by rotating the conveyor to the direction opposite to wheels. By this motion, the sand in the ground starts to get into the machine by the slope present in the front of the machine. Sand from the slope now goes to the conveyor in which the strips are fixed (used for the support of sand in the conveyor). Due to the strips, the sand will remain in its position. The conveyor is designed as a net-shaped for easy filtration of sand. Due to the size of the sand, it will get filtered and the debris in the sand will be left at the top of the conveyor. The motion continues and the debris goes to the trash box fitted at the back side of the machine. If a certain amount of wastage is collected the trash box can be taken out of the machine, disposed and kept back.

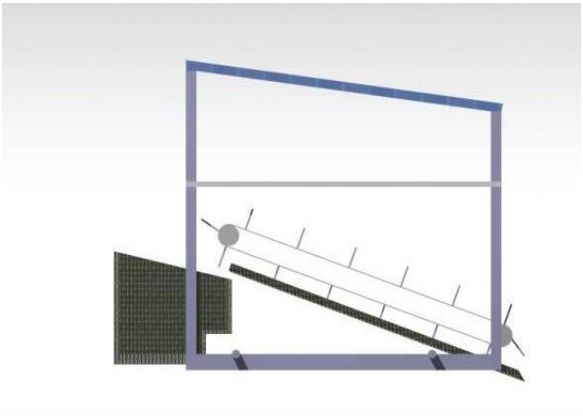

Fig 3: Garbage collector side view

5. Conclusion

The design of Garbage collector prototype was designed and the design was analyzed theoretically and then fabricated with standard materials. By introducing the solar power the cost of the power production has become zero, and since it is solar, maintenance cost also reduced. It can be made further efficient by redesigning and developing the fully automated beach cleaning machine using sensors to detect garbage levels, battery level, monitor conveyor setup, etc.

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