Solar powered waste segregation system

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Abstract. Maintenance of drains/gutters is huge problem faced by the entire world and especially our country. Manual scavenging is not only unethical but also leads to a high risk of them catching infections or poisoning due to large amounts of waste/chemicals in them. We have provided a motorized drain gutter cleansing mechanism to tackle the modern day gutter jamming issues. Our system is designed in a manner such that fluids are let to flow through but large solid waste like bottles & plastic are caught and accumulated. So human supervision is only needed to take out the segregated waste for further treatment. Hence these gutter cleaning systems can be installed at various points instead of manual labour for entire gutter floors. Since the world is also facing a fossil fuel crisis, the system will be powered with the help of solar energy so as to make it nature friendly and cost effective in the long run. Solar panels, connected to a battery power the system using the radiation received from sunlight. This makes the system not only completely automated but also, environment friendly.

1. Introduction
There are various types of wastes which can be categorized as Solid wastes that may include all sorts of garbage, sludge from a treatment plants, or contamination control offices and other disposed of materials including strong, fluid, semi-strong, or any sort of vaporous material which are the outcomes from businesses, business spots, mines and tasks identified with agribusiness and from other network exercises. Thus solid wastes can be and should be treated as unnecessary materials which can be thrown away or removed in an easy manner. Solid wastes can be solid, liquid, and semi-solid or containerized gaseous material. The liquid wastes can be differentiated as wastewater, fats, oils or grease (FOG), used oil, liquids, solids, gases, or sludge and hazardous house-hold liquids. The removal of these kinds of waste is of primary concern in the whole process of waste disposal and treatment.

The venture framework comprises of metal teeth based jaws that are at the base of the framework. It is mounted on an edge to hold the framework in the precise situation in the drain. The vertical casing is utilized to let the inflow of fluid however contain or isolate all strong waste. The machine also consists of a filter tank at the topmost position. After appropriate intervals of time the jaw lifts up with the help of a shaft which is motorized and is associated by utilizing a chain to the jaws. It at that point arrives at the top and by flipping around it dumps the strong waste. In the future the waste is dumped and the engine thus pivots again to carry the jaw to gather progressively squander subsequent to
setting off to the bottommost position. The framework is accordingly an effective path for cleaning canals just as channels and it likewise requires low force since it will most extreme turn on more than one occasion in per day so as to dump the necessary waste which is strong. Since the system doesn’t need as much power and would be much more efficient if a reusable source of energy is used, we use solar panels and a lead acid battery. This makes the system not only more effective but also environment friendly. We use the radiations that are received from the sun through the panel to power the battery. The battery then powers the system.

2. Literature Survey
Benedickt Nowak, Philipp Aschenbrenner, Franz Winter et al [1]. mixed and pelletized sewage slime debris and civil strong waste (MSW) fly debris with calcium chloride and treated in a rotary reactor at around 1000ºC. This lead to a decline in the metal fixation significantly. It also lead to an evacuation of unstable mixes (principally chlorides).

S. Sangwan and Divyanshu Goyal et al [2]. contemplated the natural and financial effects of reusing of PET plastic jug squander for traditional and sustainable wellsprings of power in India. They found that better technologies were required for removal of moisture and filament extrusion since it can reduce both environmental and economic impacts of waste PET bottle recycling. Kamali LamyaBanu, , Madhumitha, Menaka, Revathi in et al [3]. built a system that consisted of two parts i.e. segregation and waste altering. The operator uses a GSM Module with IR sensor for detecting waste; an ultrasonic sensor for volume of waste that is filled in the bin, blowers to remove plastic wastes, permanent magnet to segregate metals.

In the proposed system, waste segregation is automatically controlled using PIC Microcontroller. Hence manual power is reduced and can be easily operated. This system is more desirable and economical.Dr. Ravinder, Elarker and Amar Cholkar et al [4]. designed a system to sort refuse into metallic, wet, and dry waste. The Automated Waste Segregator identifies metallic items by employing a parallel resonant impedance sensing mechanism, and distinguishes between wet and dry waste by using capacitive sensors. Segregation of the waste at the base level serves as advantageous over the conventional segregation method. In this way “Automated Solar Powered Mini Waste Segregation Plant” serves as a life tool.

3. Methodology

3.1 Frame
The main frame used for the system to hold the mesh, jaw and storage system is made of mild steel. It is a four-part frame that is joined together using nuts and bolts.

3.2 Frame
A mesh is used to let the liquid pass through and trap the solid waste. Dimensions: 420*420mm.

3.3 Jaw
The jaw that runs over the mesh is made of aluminium and can take up to 0.5kg of weight of waste. It has 7 teeth that are 20 mm wide and at a distance of 20 mm each. Dimensions: 280*60mm

3.4 Gear
Prod gear otherwise called straight-cut riggings are probably the easiest sort of apparatuses. A prod gear comprises of a circle with the teeth anticipating radially outwards. In spite of the fact that the teeth are not straight-sided, the edge of every tooth is straight and it is adjusted corresponding to the pivot of turn. The apparatuses can work appropriately just if is fitted to the poles that are equal. There is no pivotal pushed which can be made by the tooth loads. The apparatuses are profoundly proficient at moderate speeds yet are uproarious at fast. These are utilized to increment or diminishing the torque
and furthermore power. Spike gears are utilized in clothes washers, blenders, garments dryers, development hardware, fuel siphons and factories.

### Table 1. Spur gear parameters

| Parameter     | Symbol | Formula          | Calculation       | Value  |
|---------------|--------|------------------|-------------------|--------|
| Type          | -      | -                | -                 | Spur Gear |
| Pitch Diameter| d      | N/D              | 30/0.484          | 60.5mm |
| Circular Pitch| p      | πD/N             | (3.14x62)/30      | 6.49mm |
| Diametric Pitch| P      | π/p              | 3.14/6.49         | 0.484mm |
| Module        | m      | D/N              | 62/30             | 2mm    |

3.5. Chain drive
Roller chain otherwise called the "hedge" roller chain is most generally utilized for mechanical force transmission on different residential, modern and rural hardware, including transports, wire-and cylinder drawing machines, print machines, vehicles, cruisers, as well as bicycles. It has short cylindrical rollers held in a particular series together with the help of side-links. The sprocket drives it. This type of drive is quite simple and also reliable.

### Table 2. Chain drive parameters

| Parameter          | Symbol | Formula               | Calculation       | Value  |
|--------------------|--------|-----------------------|-------------------|--------|
| Type               | -      | -                     | -                 | Roller Chain |
| Pitch Angle        | α      | α=360/z               | 360/30            | 12     |
| Circular Pitch     | P      | P=πD*sin(α/2)         | P=60.75*sin6      | 6.35mm |
| Velocity Ratio     | i      | i=N1/N2               | i=30/30           | 1      |
| Velocity of Chain  | V      | V=πDN/60              | V=(3.14*60.75*30)/60 | 0.0952m/s |
| Length of Chain    | L      | L=Ln*p               | L=202*6.35        | 1282.7mm |
| Variation in Velocity | V<sub>max</sub> - V<sub>min</sub> | V<sub>mm</sub> = 1-cos(α/z) | V<sub>mm</sub> = 1-cos(180/30) | 5.478x103 m/s |
| Power Rating       | P      | P=P1*V/1000          | P=(453.952*0.09525)/1000 | 43.204W |

3.6. DC motor
With the help of rotation these types of motors convert one form of energy into another form i.e. electrical energy to mechanical energy. They simplest type of the motor relies on the magnetic forces. Almost all types of DC motors have a mechanism, either electromechanical or electronic; to periodically change the current flow direction in part of the motor.

3.7. Brushless DC motor
Brushless motors offer many advantages as compared to brushed DC motors such as the following:
- High torque to weight proportion
- More torque per watt
- Expanded unwavering quality
- Diminished clamour
- Longer lifetime
- End of ionizing sparkles from the commutator
- Generally decrease of electromagnetic impedance (EMI).

Peak torque is produced by any machine to achieve a particular number of revolutions per minute or rpm.
Power = 24 W
Horse Power = 24/746
Multiply HP by 5252, we get

\[ 0.032 \times 5252 = 168.96 \]

Torque is given by

\[ \frac{168.96}{\text{rpm}} = \frac{168.96}{30} = 5.632 \text{ pound feet} \]

\[ \text{Torque} = 5.632 \times 4.448 \times 0.3048 = 7.64 \text{ Nm} \]

3.8. Solar panels

Polycrystalline panels are used in the system. These are also known as multi-crystalline solar panels in which the silicon in molten form is poured into moulds which are in the shape of squares. When the silicon cools down, the square moulds are cut which gives it the appearance of a wafer thus giving it the poly-crystalline shape.

Table 3. Parameters of solar panels

| Parameter                   | Value          |
|-----------------------------|----------------|
| Production Rate             | 3W             |
| Production Tolerance        | 13             |
| Max Power Current           | 0.34A          |
| Max Power Voltage           | 8.97V          |
| Short Circuit Current       | 0.37A          |
| Open Circuit Voltage        | 11.12V         |
| Weight                      | 0.7kg          |
| Dimension                   | 235mm x 195mm x 15mm |
| Max Supply Voltage          | 1000V          |
| Wind Resistance             | 2400           |
| Model Type                  | ES-3P          |

Figure 1. A schematic diagram of the model, side view
3.9. Materials used

Aluminium
- Light weight
- Corrosion resistant
- Highly ductile and malleable
- Impermeable and odourless
- Strength at low temperatures
- Nontoxic, can be easily cleaned
- Recyclable

| Table 4. Aluminium Properties |
|-------------------------------|
| Young’s Modulus | 69 GPa |
| Poisson’s Ratio | 0.33 |
| Density | 2.7 g/cm³ |
| Yield strength | 276 MPa |
| Tensile strength | 310 MPa |
| Shear Modulus | 28 GPa |

Mild Steel
- Suitable for construction and frame works due to low carbon content, making it a very strong material.
- Readily available.
- Easily malleable even at lower temperatures.
- High tensile strength and impact strength.
- Can be easily machined and welded.

| Table 5. Mild Steel Properties |
|-------------------------------|
| Young’s Modulus | 210 GPa |
| Poisson’s Ratio | 0.28 |
| Density | 7.85 g/cm³ |
| Yield strength | 370 MPa |
| Tensile strength | 400 MPa |
| Shear Modulus | 79.3 GPa |

Figure 2. Developed model, front view
4. Conclusion
This system can be used to reduce manual labour and manual scavenging. The system is powered by solar panels and battery, hence reducing environmental pollution and making it sustainable for the future. The materials used also are light and yet sturdy. So the system is portable and withstanding of moderate loads of the waste. Solar panels used are long-lasting, especially in areas of bright and heavy sunlight. Once the panels have received enough radiation, they charge the battery and can be further used for the required amounts of time duration. The solid waste is collected and the liquid waste is left to pass through hence making treatment of waste much easier. Solid waste can be further segregated based on recyclable and non-recyclable wastes and liquid waste can be purified further using different chemical processes.

The system can be altered to be used in lakes, ponds and any other stagnant water bodies. It can be used to remove wastes from larger bodies like seas and oceans if scaled to a larger model. The system will have to be constantly monitored in such cases as the volume and weight of wastes in such a case will be high.

Another major enhancement of the project will be to include a system of piezoelectric materials to harness power from the pressure generated by rain drops and other sources of tension or compression generation in a material. This way the waste itself can be used to power the battery.

5. References
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