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Design and Fabrication of Solar Powered Waste Management System

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Abstract— A trash compactor designed for public use is powered by a photovoltaic cell array. This allows the trash compactor to be placed in locations where no power is available, but with frequent traffic. The compaction feature allows the unit to be emptied less often than a typical trash container. The trash compactor can include a storage system to store power for compaction cycles. A removable bin allows easy removal of the compacted trash. The Solar-Powered Waste Management Bin is microcontroller based project that proposes a great improvement of a simple trash can which emphasizes the use of solar energy. The concept of this project is all about Green Engineering in which the design, commercialization and use of processes and products are feasible and economical while minimizing the risk to human health and the environment. In order to achieve the proposed project, RTC will be used.

Keywords— *Solar Cell, Fabrication, Waste Bin, Micro Controller.*

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I. Introduction

Waste collection is a part of the process of waste management. It is the transfer of solid waste from the point of use and disposal to the point of treatment or landfill. Waste collection also includes the curbside collection of recyclable materials that technically are not waste, as part of a municipal landfill diversion program. Household waste in economically developed countries will generally be left in waste containers or recycling bins prior to collection by a waste collector using a waste collection vehicle.

However, in many developing countries, such as Mexico and Egypt, waste left in bins or bags at the side of the road will not be removed unless residents interact with the waste collectors. Mexico City residents must haul their trash to a waste collection vehicle which makes frequent stops around each neighborhood. The waste collectors will indicate their readiness by ringing a distinctive bell and possibly shouting. Residents line up and hand their trash container to the waste collector. A tip may be expected in some neighborhoods. Private contracted waste collectors may circulate in the same neighborhood's as many as five times per day, pushing a cart with a waste container, ringing a bell and shouting to announce their presence. These private contractors are not paid a salary and survive only on the tips they receive. Later, they meet up with a waste collection vehicle to deposit their accumulated waste.

The waste collection vehicle will often take the waste to a transfer station where it will be loaded up into a larger vehicle and sent to either a landfill or alternative waste treatment facility. Waste collection considerations include type and size of bins, positioning of the bins and how often bins are to be serviced. Overfilled bins result in rubbish falling out while being tipped. Hazardous rubbish like empty petrol cans can cause fires igniting other trash when the truck compactor is operating. Bins may be locked or stored in secure areas to avoid having non-paying parties placing rubbish in the bin.

II. LITERATURE REVIEW

Years of extensive research and tons of theories explaining the facets of implementing solar powered waste management system, have been conducted by many researchers trying to derive effective and most efficient ways to discard and eliminate waste disposals via means of solar energy. Studies are being conducted in heavy volumes to understand applications and limitations of these technique.

It has been reported by Prof. Mrs. Swati Shinde, Harita Bhosle, Asha Borkar, Amit Kadve, Sneha Pichad in [1] that the problem of trash control and disposal reveals itself in many facets of our society, from carnivals and city fairs in the summer time to overfilling garbage cans in a fast food restaurant. People often attempt to cram their waste into a trash receptable already struggling to balance the trash piled on top of it. To solve this problem, an automatic trash compactor was introduced, that managed trash levels and notified when the receptacle were required to be emptied all by itself. Utilizing a trash compactor instead of a normal trashcan increased the amount of trash that can fit inside the same sized receptacle.

Therefore, the trash needs were collected less frequently. To add further convenience, the compactor used to sense when the container is full and will automatically compact the trash as needed. When the trash can no longer be compacted, it will lock itself and signal that it needs to be emptied. Several considerations were taken into account when determining this design including compression ratio of compaction, force of compaction, ease of use, sanitary considerations, and aesthetics. Main technical considerations including a compaction pressure comparable to the 15 psi seen in automatic trash compactors, as well as a container robust enough to handle pressure forces due to compaction. The method chosen as a means of compaction was a hydraulic system, actuated by pressing down on a foot pedal.

The goal of this project was to make a solar trash basket. As it was intended for commercial use, the price was an important factor to be considered. To account the same, each component that was not expensive as well as efficient was used. Also, since the trash basket used batteries for power, the batteries were required to be safe, efficient and have a long lifetime. Having used a standby time when the trash basket was not in use, batteries did last longer than usual.

Secondly, to improvise on the understanding of the technology and its appropriate application, potential consequences were required to be considered. This project utilized several complex parts, which required rigorous testing to implement successfully. The design combined electrical and mechanical parts to accomplish a task that could not be done as easily by only using one or the other.

It has been reported by Md. Abdulla Al Mamun, Mahammad A. Hannan, Aini Hussain, and Hassan Basri in [2] that an intelligent solid waste bin operates to ensure the efficient measurement of its status while consuming minimum energy. At present, major cities around the world require challenging solutions for solid waste management (SWM), as a result of growth in residential areas and the economy. SWM is thus a costly urban service that consumes around 20% to 50% of municipality's annual budget in developing countries. Furthermore, 85% of solid waste management funds are spent on waste collection and transportation. It becomes an excessive wastage of resources when bins are collected that are partially filled up. In waste collection and carrying activities, the operational cost can be reduced, by optimizing the quantity and deployment of collection bins and their collection rate. Estimating the status with waste level and weight of waste inside bins help to optimize collection routes and improve collection efficiency.

A SWM system having static scheduling and routing to collect waste demands more operating costs, longer hauling distances and increased labor hours compared to a system with dynamic scheduling and routing attitude. The authors calculated a potential cost savings of 10-20% and transport mileage savings of 26% when dynamic scheduling and routing were used. For a truly dynamic and automatic system, it is important to know the current and actual fill level of a bin rather than a prediction relays on historical fill level data, which arises questions as 'when will the bin be at an enough fill level to stick up for collection?'. So, to implement a SWM system with dynamic scheduling and routing for waste collection, it is very useful and important to get real time data about the bin status.

Several researches have been conducted over the last few decades concerning solid waste monitoring and management. But a few of them dealt with real time bin status data with a motive to implement dynamic scheduling and routing approach for an automatic solid waste management system. Estimating the bin filling level was done by capturing and processing bin's image. The system thus could capture the image when the waste collection vehicle reached in the vicinity of the bin. But the drawback to this system was that the control center used to not get the real time bin status data, as it used to depend on the historical data for collection route.

To improvise on the same, a bin was developed by using several types of sensors like light-emitting diode (LED), camera, ultrasonic, pressure etc for early detection of bin status. But the system could not respond instantly when wastes were dumped into the bin. This method thus lacked sufficient information about measurement techniques of the bin level and its dynamicity and to further improvise on the system, a system for remote monitoring of materials disassembled from end of life vehicles was developed. Both solid and liquid materials were placed in containers and fill levels were measured by using infrared image sensing. The system response was not real time. A system for collecting cardboard waste was developed where LED was to measure the container level. The system was activated once in an hour to measure the fill level and raised an alarm if certain level was exceeded. To dynamically optimize the collection route in charity sector, textile banks were developed where the top of the donated textiles pile inside a bank was measured by installing an infrared sensor underside of the roof of each bank. The server got updated data in every 12 hours. This work presented a concept to integrate several sensing technologies and algorithms to design a smart bin as a way to implement an automatic, dynamic and real time SWM system.

It has been reported by Poppy Jane Coleman and Long Duc Nghiem in [3] that the Solar Powered Compaction Garbage Bins were designed to reduce the need to empty waste receptacles in public areas. The results thereby demonstrated how solar powered compaction garbage bins could provide environmental benefits in all scenarios. The bin could hold more than six times the volume of the average 120 L mobile garbage bin, leading to the elimination of at least three out of every four collection trips. It is not only reduced operating costs, unsightly litter overflows and public disturbance, but also immensely helped in minimizing emissions from waste carrying vehicles, further benefitting the environment. The solar powered compaction garbage bins are equipped with a solar photovoltaic panel and a small battery. The battery is charged during the day allowing the unit to operate during night time. The bins automatically compact the waste when the garbage inside reached a certain level. As users deposit garbage, it falls into a bin inside the unit. When the level of garbage eventually rises above the top of the inner bin, the garbage interrupts an electric eye beam, triggering the motor to compact the garbage down into the bin, making room for additional garbage. The process repeats automatically as needed until the machine is ready for collection, typically holding about 700 L of equivalent uncompact garbage. At that point, a LED light indicator on the front panel goes from green to yellow, notifying staff that the unit is ready for collection. The bins could be colour coded and were used either for non-recycling or recycling waste materials.

An excel based cost benefit model was derived and developed to evaluate economic and environmental gains of implementing solar powered compaction garbage bins for waste management in public areas. The volume of data inputs were carefully optimized and only essential data needed for the model were requested for further research. Requested data could be categorized into three components:

- waste collection
- collection vehicles
- labor's

The cost of waste management consists of amortization of the collection vehicles, cost of garbage bins and labor costs. This approach significantly simplified the cost calculation of the solar powered compaction garbage bins for both the customers as well as the model used in this study. Carbon dioxide, nitrogen oxides and particulate matter (PM10) emission calculation was directly based on the volume of diesel fuel consumed.

It has been reported by S. Armstrong, W.G. Hurley in [4] that existing methods and described means of predicting the solar radiation in a frequently overcast climate and proposed a method for choosing the optimum tilt angle in such a climate. The effects of different load profiles on the optimum tilt angle were also investigated.

Two factors responsible for the amount of radiation received by a solar panel surface are orientation and tilt angle. The tilt angle was defined as the angle between the solar panel surface and the horizontal plane while the orientation of the solar panel was defined with respect to the horizontal plane and it is the angle between the line due south and the projection of the solar panel normal to the surface on the horizontal plane.

It has been widely acknowledged that the optimum orientation for a solar panel, in the northern hemisphere, is facing due south. For the choice of the optimum tilt angle, however, there have been several widely diverse proposals. The various schemes used to determine this optimum tilt angle are separated into two main areas ie calculating the tilt angle by latitude angle and maximizing the solar radiation falling on the solar panel. The accuracy of these methods was validated in sunny climates, where the beam portion of the global radiation dominates. In frequently overcast climates, the beam radiation significantly diminished and the diffuse radiation was prominent. The optimum tilt angles were largely determined by the beam radiation component but in overcast conditions, the diffuse component became more significant. In the absence of measured global radiation data, solar radiation models were used to calculate the radiation.

A new methodology to calculate the solar radiation was proposed which combined hourly observations of cloud conditions with monthly sunshine hour's data in order to determine the frequency of clear, partly cloudy and overcast skies. This method provided a more accurate prediction of the diffuse radiation under varying sky conditions. The solar radiation model is still subsequently used for determining the optimum tilt angle by taking into account the frequency and intensity of the cloud cover. The tilt angle optimized the beam radiation on clear days and diffused radiation on overcast days.

In this paper, the researcher also suggested further possible future works that addressed the shortcomings identified in the paper, such as including the average transmittance characteristics of localized cloud cover in order to increase the accuracy of the solar radiation model.

III CONSTRUCTIONAL FEATURES
D C MOTOR

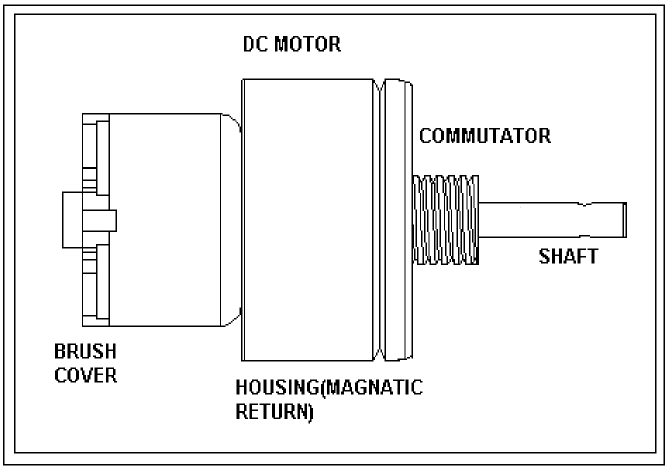

Fig.1: DC Motor

In any electric motor, operation is based on simple electromagnetism. A current carrying conductor generates a magnetic field when it is placed in an external magnetic field, it will experience a force proportional to the current in the conductor and to the strength of the external magnetic field. The opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor as shown in Fig.1 is designed to harness the magnetic interaction between a current carrying conductor and an external magnetic field to generate rotational motion.

Consider the Fig.2 of a simple 2-pole DC electric motor (here red represents a magnet or winding with a "North" polarization, while green represents a magnet or winding with a "South" polarization).

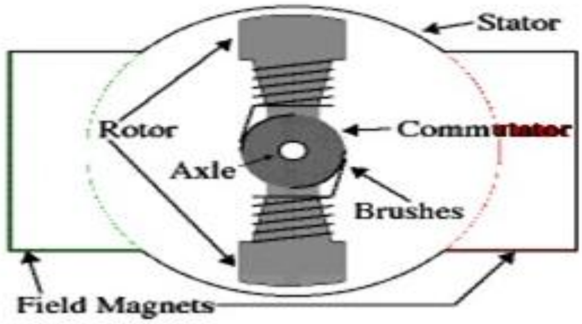

Fig .2: Sectional View of DC Motor

Every DC motor has six basic parts; Axle, rotor (armature), stator, commutator, field magnets and brushes. In most common DC motors, the external magnetic field is produced by high strength permanent magnets. The stator is the stationary part of the motor which includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor (together with the axle and attached commutator) rotate with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout with the rotor inside the stator (field) magnets.

The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts and energize the next winding. Given the example of two pole motor, the rotation reverses the direction of current through the rotor winding, leading to a flip of the rotor's magnetic field, driving it to continue rotating.

In real life, DC motors will always have more than two poles (three is a very common number). In particular, this avoids "dead spots" in the commutator. You can imagine how with our example two pole motor, if the rotor is exactly at the middle of its rotation (perfectly aligned with the field magnets), it will get stuck there. Meanwhile, with a two pole motor, there is a moment where the commutator shorts out the power supply. This would be bad for the power supply, waste energy and damage motor components as well. Yet another disadvantage of such a simple motor is that it would exhibit a high amount of torque "ripple" (the amount of torque it could produce is cyclic with the position of the rotor).

Here one pole is fully energized at a time (but two others are "partially" energized). As each brush transitions from one commutator contact to the next, one coil's field will rapidly collapse, as the next coil's field will rapidly charge up (this occurs within a few microsecond).

There is probably no better way to see how an average DC motor is put together, than by just opening one up. Unfortunately this is tedious work, as well as requiring the destruction of a perfectly good motor. The guts of a disassembled Mabuchi FF-030-PN motor (the same model that Solarbotics cells) are available for (on 10 lines / cm graph paper). This is a basic 3 pole DC motor, with 2 brushes and three commutator contacts. The use of an iron core armature (as in the Mabuchi, above) is quite common and has a number of advantages. Thus the iron core provides a strong, rigid support for the windings, a particularly important consideration for high torque motors. The core also conducts heat away from the rotor windings, allowing the motor to be driven harder than might otherwise be the case. Iron core construction is also relatively inexpensive compared with other construction types.

But iron core construction also has several disadvantages. The iron armature has a relatively high inertia which limits motor acceleration. This construction also results in high winding inductances which limit brush and commutator life.

In small motors, an alternative design is often used which features a 'coreless' armature winding. This design depends upon the coil wire itself for structural integrity. As a result, the armature is hollow and the permanent magnet can be mounted inside the rotor coil. Coreless DC motors have much lower armature inductance than iron core motors of comparable size, extending brush and commutator life.

The coreless design also allows manufacturers to build smaller motors, but due to the lack of iron in their rotors, coreless motors are somewhat prone to overheating. As a result, this design is generally used just in small, low powered motors. Beamers will most often see coreless DC motors in the form of pager motors. Again, disassembling a coreless motor can be instructive in this case. The guts of this disassembled motor are available (on 10 lines / cm graph paper) which is a 3 pole coreless DC motor.

LEAD SCREW

A lead screw is also known as a power screw or translation screw which is designed to translate radial motion into linear motion. Common applications are machine slides (such as in machine tools), vises, presses and jacks. A lead screw nut and screw mate with rubbing surfaces and consequently they have a relatively high friction and stiction compared to mechanical parts which mate with rolling surfaces and bearings. Their efficiency is typically between 25 and 70% with higher pitch screws tending to be more efficient.

A higher performing and more expensive alternative is a ball screw.

The high internal friction means that lead screw systems are not usually capable of continuous operation at high speed, as they will overheat. Due to inherently high stiction, the typical screw is self-locking (i.e. when stopped, a linear force on the nut will not apply a torque to the screw) and are often used in applications where back driving is unacceptable, like holding vertical loads or in hand cranked machine tools.

Lead screws are typically used well-greased with an appropriate nut, it may be run dry with somewhat higher friction. There is often a choice of nuts and manufacturers will specify screw and nut combinations as a set. The mechanical advantage of a lead screw is determined by the screw pitch and lead. For multi start screws the mechanical advantage is lower, but the travelling speed is better. Backlash can be reduced with the use of a second nut to create a static loading force known as preload and the nut can be cut along a radius and preloaded by clamping that cut back together. A lead screw will back drive. A lead screw's tendency to back drive depends on its thread helix angle, coefficient of friction of the interface of the components (screw/nut) and the included angle of the thread form. In general, a steel acme thread and bronze nut will back drive when the helix angle of the thread is greater than 20°.

SOLAR PANEL

- A solar panel is a device that collects and converts solar energy into electricity or heat. It is known as photovoltaic panels used to generate electricity directly from sunlight. Solar thermal energy collection systems are used to generate electricity through a system of mirrors and fluid filled tubes. It is known as energy portal. A solar power technology uses solar cells or solar photovoltaic arrays to convert light from the sun directly into electricity. Photovoltaics is the process in which light energy is converted into electrical power. It is best known as a method for generating solar power by using solar cells packaged in photovoltaic modules, often electrically connected in multiples as solar photovoltaic arrays to convert energy from the sun into electricity. The photovoltaic solar panel is photons from sunlight knock electrons into a higher state of energy, creating electricity.
- Solar cells produce direct current electricity from light which can be used to power equipment or to recharge a battery. A less common form of the technologies is thermo-photovoltaics, in which the thermal radiation from some hot body other than the sun is utilized. Photovoltaic devices are also used to produce electricity in optical wireless power transmission.

LIMIT SWITCH

A mechanical limit switch interlocks a mechanical motion or position with an electrical circuit. A good starting point for limit switch selection is contact arrangement. The most common limit switch is the single pole contact block with one NO and one NC set of contacts. However, limit switches are available with up to four poles. Limit switches are also available with time delayed contact transfer. This type is useful in detecting jams that cause the limit switch to remain actuated beyond a predetermined time interval. Other limit switch contact arrangements include neutral position and two step. Limit switches feature a neutral-position or center off type transfers one set of contacts with movement of the lever in one direction. Lever movement in the opposite direction transfers the other set of contacts. Limit switches with a two-step arrangement, a small movement of the lever transfers one set of contacts, and further lever movement in the same direction transfers the other set of contacts. Maintained contact limit switches require a second definite reset motion. These limit switches are primarily used with reciprocating actuators, or where position memory or manual reset is required. Spring return limit switches automatically reset when the actuating force is removed.

CENTRIFUGAL LIMIT SWITCHES

A centrifugal limit switch is actuated by speed only. Simple types of centrifugal limit switches consist of speed sensing units that mount directly on a rotating shaft and a stationary contact switch assembly. The basic control element is a conical spring steel disc that has centrifugal weights fastened to the outer edge of its circular base. Fingers on the spring are attached to an insulating spool that rides free of the shaft and actuates the movable switch contact. As the rotating sensing unit reaches switching speed, the centrifugal force of the calibrated weights overcomes spring force, resulting in an instantaneous axial displacement of the spring and the contact actuating spool.

The contacts switch at one speed as speed increases from zero to operating speed, and at a lower speed as rotation slows from operating speed toward zero. The spring decreasingly opposes centrifugal force as rotational speed increases from standstill until the snap over point is reached. Then, spring force adds to centrifugal force to axially snap the spool and actuate the contacts. As rotational speed decreases from operating speed, spring force overcomes the centrifugal force of the weights at a lower speed where snapback begins.

BATTERY

In this project secondary type of battery is used and it is rechargeable. A battery is one or more electrochemical cells, which store chemical energy and make it available as electric current. There are two types of batteries, primary (disposable) and secondary (rechargeable), both of which convert chemical energy to electrical energy. Primary batteries can only be used once because they use up their chemicals in an irreversible reaction. Secondary batteries can be recharged because the chemical reactions they use are reversible and they are recharged by running a charging current through the battery, but in the opposite direction of the discharge current. Secondary, also called as rechargeable batteries can be charged and discharged many times before wearing out. After wearing out some batteries can be recycled.

Batteries have gained popularity as they became portable and useful for many purposes. The use of batteries has created many environmental concerns such as toxic metal pollution. A battery is a device that converts chemical energy directly to electrical energy and consists of one or more voltaic cells. Each voltaic cell consists of two half cells connected in series by a conductive electrolyte. One half cell is the positive electrode and the other is the negative electrode. The electrodes do not touch each other but are electrically connected by the electrolyte which can be either solid or liquid. A battery can be simply modelled as a perfect voltage source which has its own resistance and resulting voltage across the load depends on the ratio of the battery's internal resistance to the resistance of the load.

When the battery is fresh, its internal resistance is low, hence the voltage across the load is almost equal to that of the battery's internal voltage source. As the battery runs down and its internal resistance increases, the voltage drop across its internal resistance increases, so the voltage at its terminals decreases and the battery's ability to deliver power to the load decreases.

CONTROL UNIT

In this project the main device is a micro controller. It is used to control the whole unit of this project. The micro controller is connected to the control unit. The control unit is connected with the battery to get the power supply. Microcontrollers are destined to play an increasingly important role in revolutionizing various industries and influencing our day to day life more strongly than one can imagine. Since its emergence in the early 1980's the microcontroller has been recognized as a general purpose building block for intelligent digital systems. Its diverse use starting from simple children's toys to highly complex spacecraft. Because of its versatility and many advantages, the application domain has spread in all conceivable directions making it ubiquitous. As a consequence, it has generated a great deal of interest and enthusiasm among students, teachers and practicing engineers, creating an acute education need for imparting the knowledge of microcontroller based system design and development. It identifies the vital features responsible for their tremendous impact, the acute educational need created by them and provides a glimpse of the major application area.

ADVANTAGES OF MICROCONTROLLERS

If a system is developed with a microprocessor, the designer has to go for external memory such as RAM, ROM or EPROM and peripherals and hence the size of the PCB will be large enough to hold all the required peripherals. But the micro controller has got all these peripheral facilities on a single chip, therefore development of a similar system with a micro controller reduces PCB size and cost of the design.

One of the major differences between a micro controller and a microprocessor is that a controller often deals with bits, not bytes as in the real world application, for example switch contacts can only be open or close, indicators should be light or dark and motors can be either turned on or off and so forth.

WASTE BIN

Specifications:

Length of the bin = 0.60m

Breadth of the bin = 0.45m

Height of the bin = 0.75m

Volume of the bin = 0.2025m^3

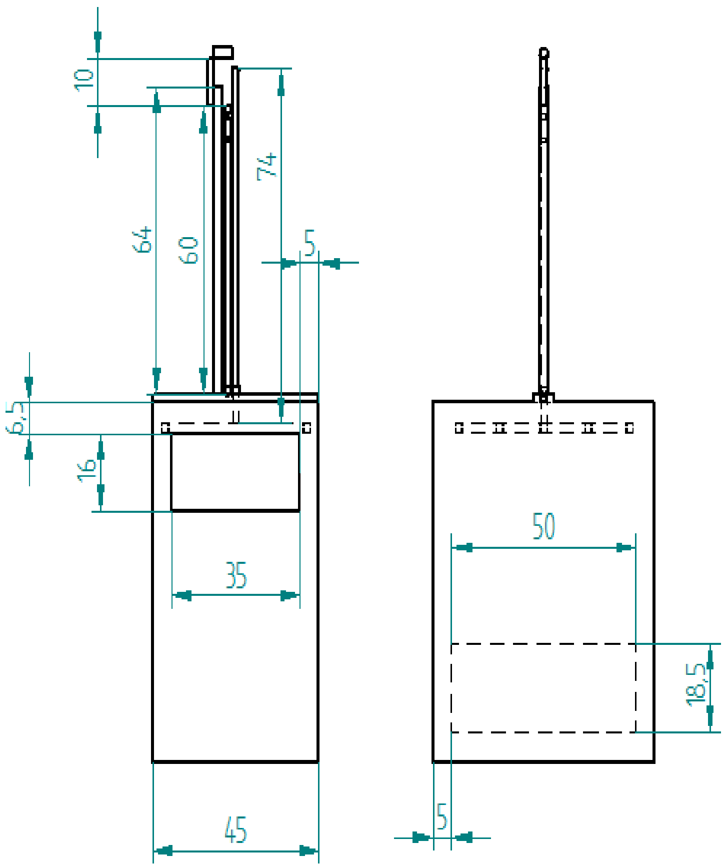

Fig .3: CAD Model of Waste Bin

Description:

This is the main part of the model which is used to store the waste and to compress the waste materials so as to increase the capacity of the waste bin. The material used is Mild Steel. The waste bin is of cuboidal shape as shown in Fig.3. Any type of waste materials ranging from paper waste to plastic waste can be compressed inside the bin. It has an opening in the front face for receiving the waste and another opening in the side face for removing the waste. The top face of the bin has a metallic frame which supports the screw rod and motor setup. The piston reciprocates inside the bin.

PISTON

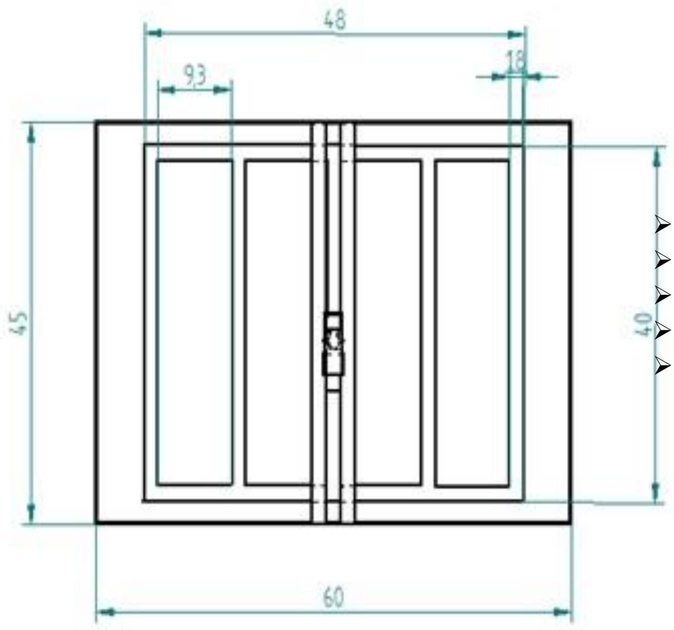

Fig.4: CAD Model of Piston

Specification:

Length of the piston = 0.48 m
Breadth of the piston = 0.40 m
Thickness of the piston = 0.018 m
Length of piston rod = 0.74 m

Description:

The rotary motion of the lead screw which is driven by the motor is converted into linear motion of the piston by using bolt and nut setup. The piston as shown in Fig.4 reciprocates inside the bin which compresses the waste inside the bin. The material used for piston is mild steel.

IV LIST OF MATERIALS

MATERIAL SELECTION FACTORS

The various factors which determine the choice of material are discussed below.

PROPERTIES

The material selected must possess the necessary properties for the proposed application. The various requirements to be satisfied can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability etc.

The following four types of principle properties of materials decisively affect their selection.

a] Physical
b] Mechanical
c] From manufacturing point of view
d] Chemical

The various physical properties concerned are melting point, thermal conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purpose etc. The various mechanical properties concerned are strength in tensile, compressive shear, bending, torsion and buckling load, fatigue resistance, impact resistance, elastic limit, endurance limit and modulus of elasticity, hardness, wear resistance and sliding properties.

The various properties concerned from the manufacturing point of view are,

- Cast ability
- Weld ability
- Surface properties
- Shrinkage
- Deep drawing etc.

MANUFACTURING CASE

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable coating substances may demand the use of special materials.

QUALITY REQUIRED

This generally affects the manufacturing process and ultimately the material. For example, it would never be desirable to go casting of a less number of components which can be fabricated much more economically by welding or hand forging the steel.

AVAILABILITY OF MATERIAL

Some materials may be scarce or in short supply, it then becomes obligatory for the designer to use some other material which though may not be a perfect substitute for the material designed. The delivery of materials and the delivery date of product should also be kept in mind.

SPACE CONSIDERATION

Sometimes high strength materials have to be selected because the forces involved are high and space limitations are there.

V. WORKING PRINCIPLE

In this setup, the energy stored from the solar panel is used to supply 12V to the relay driver circuit. The relay circuit controls the motor. The voltage is not directly supplied with the voltage from battery, rather a 7805 regulator is which allows only 5V to pass through it. Again the signal is filtered for better life of the equipment's. The microcontroller and RTC (real time clock) works under 5V whereas the relay driver circuit works under 12V as mentioned above. The RTC is used to keep track of the real time even though the circuit is off. For this purpose a cell is provided in the system. A keypad is used in the circuit so as to control and direct the piston. An Automatic key is provided so as to allow the piston to compress and return to its initial position automatically after a prescribed time interval. This can be set in the system according to the convenience. The microcontroller uses a 40 pin IC. Thus when the voltage is passed to the relay driver circuit, the instruction is given to the motor. The 30 RPM motor rotates. The screw rod connected to the motor rotates and the piston connected to the screw rod gets compressed. When the compression process continues to a particular level and when the piston setup touches the limit switch, the compression stops. In Automatic mode the piston returns to its initial position whereas in the manual mode, the piston stops. When the piston initiates compression, the waste particles present in the bin gets compressed and hence increases the capacity of the bin.

ADVANTAGES

- Enlarge the space for collecting waste
- Low cost
- Easily maintained
- Can be used in waste disposal systems to increase the capacity
- Prevents the flooding of waste to environment thus preventing environmental pollution

DISADVANTAGES

- Need control unit
- Expensive compared to ordinary waste bins
- Economical in densely populated areas where rate of waste disposal is high
- Since the system uses solar energy, sunlight is necessary for at least 3 hours in a period of 3 days.

VI CALCULATIONS

DC MOTOR

SPECIFICATION:

Speed N = 30 RPM
Voltage V = 12 Volt
Current I = 0.3 A (loading condition)
Current I = 0.06 A (No Load Condition)
Power P = V x I
= 12x0.3
P = 3.6 WATT
1 WATT = 0.00134102 HP
3.6 WATT = 3.6 X 0.00134102
P = 0.0048 HP
Motor Efficiency = 36%

FORMULAE

Good science project does not stop with building a motor. It is very important to measure different electrical and mechanical parameters of the motor and calculate unknown values using the following helpful formulas. This formula could be used in many cases. The resistance of the motor can be calculated by measuring the consumed current and applied voltage. For any given resistance (in the motors it is basically the resistance of the coil) this formula explains that the current can be controlled by applied voltage.

Electrical power of the motor is defined by the following formula: $\mathbf{P_{in} = I * V}$

Where,

P_{in} – Input power, measured in watts (W)
I – Current, measured in amperes (A)
V – Applied voltage, measured in volts (V)

Motor speed and torque are the two important parameters in any motor. Hence it is very important to consider these factors while calculating power of the motor. Output mechanical power of the motor could be calculated by using the following formula $\mathbf{P_{out} = T * \omega}$

Where,

Pout – Output power, measured in watts (W)
τ – Torque, measured in Newton meters (Nm)
ω – Angular speed, measured in radians per second (rad/s).

Angular speed of the motor can be found out by knowing the rotational speed of the motor in rpm.

$$\mathbf{\Omega = N * 2\pi / 60}$$

Where,

ω – Angular speed, measured in radians per second (rad/s);
Rpm – rotational speed in revolutions per minute;
π – Mathematical constant pi (3.14).
60 – Number of seconds in a minute.

Efficiency of the motor can be calculated by ratio of mechanical output power to electrical input power:

$$\mathbf{E = P_{out} / P_{in}}$$

Therefore

$$\mathbf{P_{out} = P_{in} * E}$$

After substitution we get

$$\mathbf{T * \omega = I * V * E}$$

$$\mathbf{T * N * 2\pi / 60 = I * V * E}$$

Motor torque changes with the speed. At no load there will be maximum speed and zero torque. Load adds mechanical resistance. The motor starts to consume more current to overcome this resistance and the speed decreases. If the load is increased at some point, the motor stops (this is called stall). When it occurs, the torque is at maximum and it is called stall torque. While it is hard to measure stall torque without special tools it can be found out by plotting speed v/s torque graph. To find the stall torque it is required to take at least two measurements with different loads.

TORQUE OF THE MOTOR

The formula for calculating torque will be

$$T = (I * V * E * 60) / (N * 2\pi)$$
$$= (0.3x12x0.36x60)/30x2\pi$$

Torque = 0.412 Nm
1Kg-cm = 0.0980665 Nm
1 Nm = (1/.0980665)
=10.197 kg-cm
(10.197 x .412) = 4.20 kg-cm
Torque (T) = 4.20 kg-cm

LEADSCREW CALCULATION

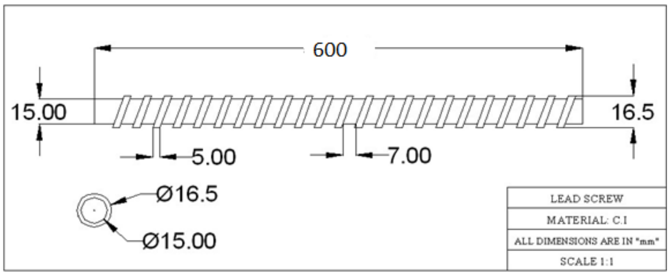

Fig.5: Lead screw

Speed of the motor, N = 30 rpm

Pitch of lead screw = 7 mm

The linear velocity of the lead screw = 30 x 7

= 210 mm/min

The angular velocity of the lead screw = $2\pi N/60$

= 0.5253 radian/s

Power of the lead screw, P = 12 W

Torque of the lead screw = P x $60/2\pi N$

= 3.81 Nm

Maximum withstanding capacity = torque/radius of lead screw

= 3.81/.00825

= 461.81 N

SOLAR PANEL CALCUALTION

VOLT = 12 V

WATT = 5 W

W = V X I

5 = 12 X I

I = 5/12

I = 420ma

BATTERY CALCULATION

B_{AH}/C_I = 2.7 ah/420ma

= 6.43 hrs.

To find the Current

Watt = 18 w

Volt = 12v

Current =?

P = V x I

18 = 12 x I

I = 18/12

= 1.5 A

Battery usage with 1.5A

B_{AH}/I

2.7/1.5 = 1.8 hrs.

WIND LOAD CALCULATIONS FOR SOLAR PANEL PARAMETERS

V = wind speed, in m/s (6 m/s)

P = air density, in 1.2 kg/m^3

C_p = power Coefficient, 0.4

Θ = inclination of photo voltaic cell take (Θ = 20^0)

S = the surface area of the photovoltaic panel, m^2

WIND LOAD CALCULATIONS:

$$F_{\perp} = \rho \times v^2 \times S \times sin^2\theta$$

= 1.2 x 6 x 6 x 275 x 125 x (sin 20^0)^2

= 173.71 KN

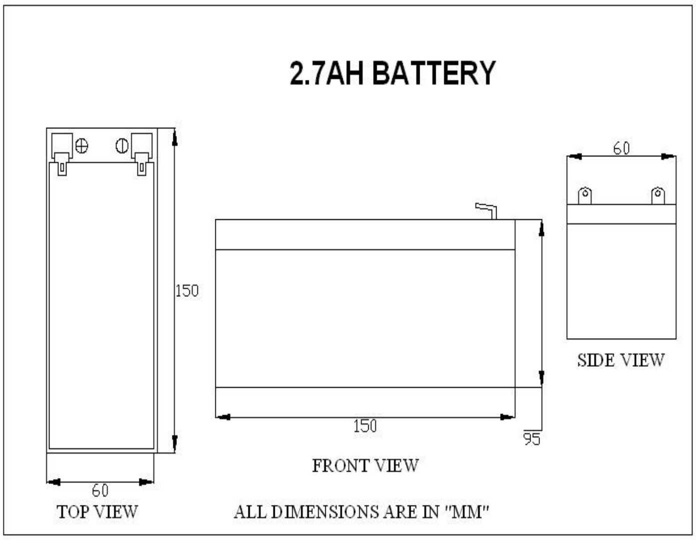

Fig.6**:** Views and Details of Battery

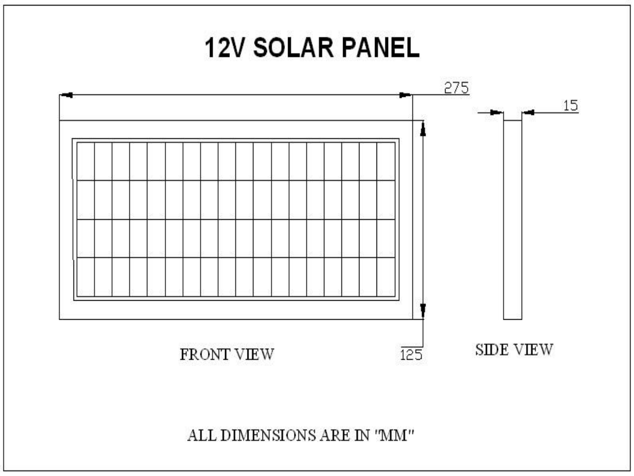

Fig.7**:** Views and Details of Solar Panel

VII CONCLUSION

Human ways of life have placed pressure on the environment and have caused imbalance in the ecosystem, by producing, consuming and wasting of natural resources. Most countries evidently have major effects on the environment due to waste generation with economic development since natural resources are used and waste and pollution are produced. Therefore, the concern towards waste disposal management has increased as an integral part of sustainable development.

Thus, a continuing rise in the rate of waste production is no longer acceptable as hazardous waste affects immensely the health of millions of people and poisons large areas of our planet. In many places people live surrounded by garbage and landfills.

Hence as a global cry out for efficient and effective alternative energy sources, solar powered waste management system would solve this major problem of waste disposal by deriving its energy from the sun and harnessing power of technology to solve an expensive and messy problem how to efficiently manage the process of collecting solid waste and being able to discard them, significantly reducing fossil fuel consumption and greenhouse gas emissions.

VIII SCOPE OF FUTURE WORK

One of the main work that can be included to this project is the addition of GPS (Global Positioning System) tracking and messaging system which will send a message when maximum amount of compaction is done and it would help to reduce the visit to site by 80 percent. The three sides of the bin can be used for showing electronic advertisements using LED screens which can fetch the authorities concerned as a revenue for the bins maintenance. A public message can also be displaced instead of advertisements for spreading awareness. It can also be used as a public wifi hotspot for providing wifi in public places. It will not consumes more energy since it is solar powered, it may require a panel and battery which is more efficient than one which is used now.

A sensor can be used instead of real time clock which senses the amount of waste and does the compression. It will save the energy of frequent compressions in a place where the amount of waste falling to the bin is less in less and will be suited for less populated areas or towns.

REFERENCES

1. 1] Swati Shinde and Haritha Bhosle(2014) –"Review on Solar Trash Compaction", *International Journal of Engineering and Technical Research*, Volume 2, Issue11, 137-140
2. 2] Md.Abdulla Al Mamun, Mahammad A Hannan and Aini Hussain (2014)-"Integrated Sensing Systems and Algorithms for Solid Waste Bin State Management Automation", *IEEE Sensors Journal*, Volume 15, Issue 1, 561-566
3. 3] Poppy Jane Coleman and Long Duc Nghiem (2010)-"Solar-Powered Compaction Garbage Bins in Public Areas: A Preliminary Economic and Environmental Evaluation", *University of Wollongong, Australia*, Volume 2, 524-532
4. 4] S. Armstrong and W G Hurley (2009)-"A new methodology to optimize solar energy extraction under cloudy conditions", *Power Electronics Research Centre, National University of Ireland, Galway, Ireland*, Volume 35, 780-787
5. 5] Jonas Van Ackere and Jeroen Belien (2011)-"Municipal Solid Waste Collection Problems", *Research Center for Informatics, Modelling and Simulation, Warmoesberg, Belgium*, Volume 34, 1-34