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Design and Development of Low-Cost Solar Operated Drainage Cleaning System

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Abstract:
The increasing problem of clogged drainage systems in urban and rural areas leads to waterlogging, unhygienic conditions, and the spread of diseases. Manual cleaning is labour-intensive, costly, and hazardous for workers. This project proposes a low-cost, solar-operated drainage cleaning system that automates the removal of waste from drains using renewable energy.
The system consists of a solar panel, DC motor, conveyor belt mechanism, waste collector, and filtration unit. It is designed to be energy-efficient, eco-friendly, and cost-effective. The prototype was tested in real-world conditions, demonstrating effective waste collection and improved drainage maintenance.

Keywords: Solar-powered, drainage cleaning, automation, waste management, sustainable technology.

1. INTRODUCTION

The evolution of cities throughout history has sparked the creation of new technologies, improved infrastructure, and changes in living conditions, all while driving global economic growth. Yet, despite these advancements, the development of effective drainage systems remains lacking. The accumulation of solid waste like paper, plastic wrappers, leaves, and various organic materials often clogs drains, leading to waterlogging. This, in turn, fosters the spread of waterborne diseases and contributes to environmental pollution.
As populations swell and industrial growth expands, many developing nations face significant challenges. This situation often forces people to rely heavily on automated processes, which can replace manual labour that is typically faster and uses basic tools like brooms and buckets. However, every tool comes with its own set of risks. For instance, using buckets can lead to long-term health issues and skin infections.
Humans, or as we often say, mankind, tend to highlight the advantages and benefits of each tool, which ultimately supports social customs and interactions. Additionally, techniques like mechanics allow tasks to be completed quickly and efficiently, conserving energy and time.

2. LITERATURE REVIEW

The literature review is a critical step in understanding the current state of technology and research related to drainage cleaning systems, particularly those powered by renewable energy sources like solar power. Over the years, various mechanical and automated methods have been developed to tackle the persistent problem of debris accumulation in drainage channels, which causes blockages, waterlogging, and

environmental hazards. Many researchers have focused on designing systems that reduce manual labour, improve cleaning efficiency, and promote environmental sustainability.

Daniels [1] The literature on drainage cleaning systems presents various innovative solutions aimed at addressing environmental hazards caused by blocked drainage channels. developed a drainage cleaning system that leverages the natural flow of water in drainage lines to assist in debris removal. This method is cost-effective and simple, utilizing hydraulic forces already present within the drainage system to minimize blockages.

Kalyankumar [2] proposed a Design and fabrication of drainage cleaning equipment. The device might be cleaned sometimes manually or this sort of device might be designed with the intention to robotically throw out wastages and should maintain the water smooth. This task enables to scrub water within the device whenever any wastage seems which is an green and straightforward manner of cleansing the device and stopping the blockage. It additionally reduces human energy and improves the standard of water it truly is cleaned

Balashanmgam [3] Introduced a Design and Fabrication of semi-automatic drainage cleaning system. automatically operated drainage cleaner is discussed and newly included features are discussed and their applications. The problem of flooding and climate change has become outrageous because of its recent trends in our environment today. Water running through a water drainage system mostly carries along waste materials most which are non-biodegradable which not only cause flooding but also climate change. Overflow of water drainage system occurs when there is a blockage of an end of the drainage system forcing the water to find its way elsewhere apart from the mapped-out drainage system, therefore the running water spills over the horizontal height of the drainage systems spreading to regions alongside the drainage system, thereby causing problems such as pushing down of structures such as fences, water logging of farm lands and residential building.

Sharma [4] The Automatic drainage cleaning system is used to clean the drainage system automatically by the ADCS Machine, which is operated mechanically with the help of several arrangement of various components of machine and various linkages. The water flowing in drainage have various impurities which having plastic bottles, polythene, dirt and other solid waste. Due to blocking of drainage system, we may face several problems in rainy seasons as well as normal days. Due to blocking of drainage, we see that the wastes get overflow on the roads which is a big problem mostly in rainy season

3. DESCRIPTION OF COMPONENTS

3.1. DC Motor

A DC motor in simple words is a device that converts electrical energy (direct current system) into mechanical energy. If a current carrying conductor is placed in a magnetic field perpendicular, after the conductor experience a force in the direction mutually perpendicular to both the direction of field and the current carrying conductor, DC motor working on Fleming's left-hand rule. The DC or direct current motor works on the principal, when a current carrying conductor is placed in a magnetic field, If the direction of current in the wire is reversed, the direction of rotation also reverses. When magnetic field and electric field interact, they produce a mechanical force, and based on that the working principle of DC motor is established.

Fig.No.3.1. DC Motor

3.2. Roller Chain

Roller chain is the type of chain drive most used for transmission of mechanical power on many kinds of domestic, industrial, and agricultural machinery, including conveyors, wire- and tube-drawing machines, printing presses, cars, motorcycles, and bicycles. It consists of a series of short cylindrical rollers held together by side links. It is driven by a toothed wheel called a sprocket. It is a simple, reliable, and efficient means of power transmission. The roller chain design reduces friction compared to simpler designs, resulting in higher efficiency and less wear. The original power transmission chain varieties lacked rollers and bushings, with both the inner and outer plates held by pins which directly contacted the sprocket teeth.

Fig.No.3.2 Roller Chain

3.3. Sprockets

A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain (or) indented material. The sprocket wheel engages a chain and run over it. Sprockets are used in bicycles, motorcycles, cars, tracked vehicles, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc. Perhaps the most common form of sprocket may be found in the bicycle, in which the pedal shaft carries a large sprocket-wheel, which drives a chain, which, in turn, drives a small sprocket on the axle of the rear wheel. Early automobiles were also largely driven by sprocket and chain mechanism, a practice largely copied from bicycles. They can be run at high speed and some forms of chain are so constructed as to be noiseless even at high speed.

Fig.No.3.3. Sprocket

3.4. Bearings

A bearing is a device designed to allow smooth motion in a fixed direction between two parts, usually involving either rotation or linear movement. You can generally categorize bearings based on the types of motion they permit and how they operate. Among the various types, the most common are plain bearings and roller bearings. Essentially, a bearing is a machine component that restricts relative motion to just the intended movement while also reducing friction between the moving parts. For instance, a bearing can be designed to enable free linear movement of a part or allow it to rotate freely around a fixed axis. Alternatively, it can control motion by managing the normal forces acting on the moving components. Most bearings work by minimizing friction to facilitate the desired motion. Rotary bearings, for example, support rotating elements like shafts or axles in mechanical systems, transferring both axial and radial loads from the source to the structure that supports it.

Fig.No.3.4. Bearing

3.5. Battery

Batteries are fascinating devices that transform chemical energy straight into electrical energy. Essentially, a battery is made up of several voltaic cells. Each of these cells has two half-cells that are linked together in series by a conductive electrolyte, which contains both anions and cations. When you connect a battery

to an external circuit, the electrolytes can move around as ions, enabling the chemical reactions to take place at the different terminals, thus providing energy to the external circuit. It is this movement of ions within the battery that allows current to flow out and do some work.

Fig.No.3.5. Battery

3.6. Solar Panel

Solar panels are fascinating devices designed to capture sunlight and transform it into electricity or heat. Essentially, a solar panel consists of a series of solar (or photovoltaic) cells that harness the photovoltaic effect to generate power. These cells are neatly arranged in a grid pattern across the panel's surface. Most commonly, you will find that these panels are made with crystalline silicon solar cells. Nowadays, solar panels are popping up in all sorts of electronic gadgets, like calculators, which only work when there's sunlight available. However, one significant downside is that solar panels can be expensive. Plus, they need to be installed outdoors since they rely on sunlight to function effectively.

Fig.No.3.6. Solar Panel

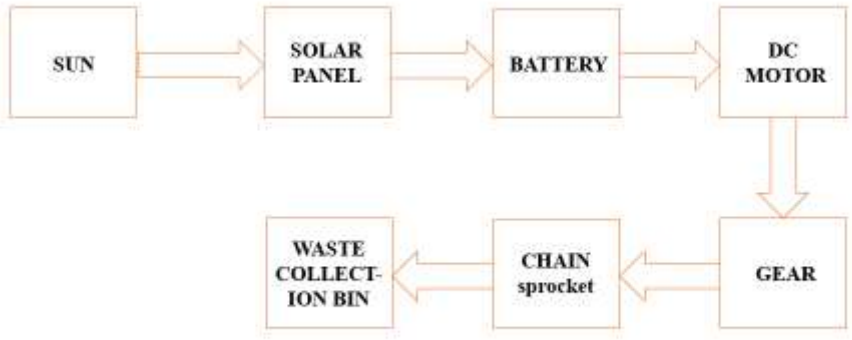

Fig.No.4.1. Block Diagram of Working Principle

4. WORKING PRINCIPAL

The operational principle behind the creation of an automatic drainage cleaning machine involves integrating several essential components, including a motor, a conveyor system, and a control system. Initially, the machine employs its motor-driven system to traverse drainage pipes, guided by inputs. Upon detecting a blockage, the control system activates the relevant cleaning mechanisms such as rotating brushes or high-pressure water jets to dislodge and break down debris. This debris is subsequently collected by the conveyor system or a suction unit, which transports it to a storage compartment within the machine for future disposal. Throughout its operation, the machine's progress and effectiveness are monitored remotely, enabling operators to make necessary adjustments. This automated process not only enhances cleaning efficiency but also reduces the need for manual labour and improves safety by minimizing human exposure to potentially hazardous environments within drainage systems.

By automating the drainage cleaning process, the machine reduces the need for manual labour, thereby minimizing human exposure to potentially hazardous environments within drainage systems. This not only enhances safety but also improves cleaning efficiency, ensuring that drainage systems are maintained effectively with minimal human intervention. The automation also leads to consistent cleaning performance, reducing the variability associated with manual labour.

The integration of solar power ensures that the machine operates sustainably, reducing greenhouse gas emissions associated with traditional power sources. Additionally, the use of environmentally friendly cleaning agents and filtration systems minimizes the ecological footprint of the cleaning process. This commitment to sustainability aligns with global efforts to reduce environmental impact and promote green technologies.

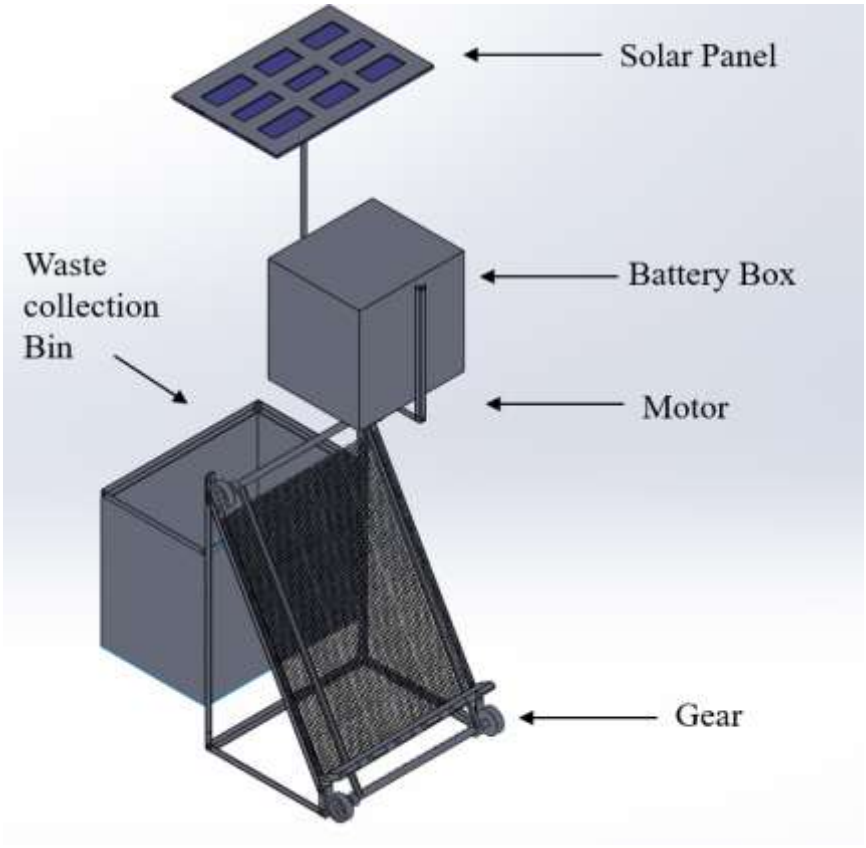

Fig.No.4.2. CAD Model

5. ADVANTAGES

- Production Cost is very low.
- Its Operated and maintenance is simple.
- It can be efficiently used.
- Light weight and easily portable.
- Large amount of garbage will collect which can be manufacturable.

6. APPLICATIONS

- It is used almost in all types of drainage (Large, Small, and Medium).
- This Machine is mainly used in cleaning system.
- Project to use this efficient way to control the disposal of wastages and with regular filtration of wastages.

6. CONCLUSION

The creation of the Automatic Drainage Cleaning Machine signifies a breakthrough in tackling the issues related to urban sanitation and upkeep. This cutting-edge machine not only improves the effectiveness of cleaning drainage systems but also mitigates the health hazards linked to manual cleaning, thus fostering a safer working environment. By automating the cleaning process, the machine reduces human exposure to hazardous waste and enhances resource utilization.

Additionally, the adoption of this technology could contribute to more sustainable urban living conditions by ensuring cleaner, unobstructed drainage systems. The success of this initiative illustrates the potential

for further technological advancements in urban management and bolsters the quest for more sophisticated automated solutions in public service maintenance.

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