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Experimental analysis of semi-automatic drainage cleaner

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ABSTRACT

Drainage system plays a vital role in all domestic and industrial applications in the proper disposal of sewage from domestic, industries and commercials are still a challenging task. Drainage pipes are used for disposal, and it is possible that human life may be lost when clearing blockages in the drainage system. This study focuses on residential and industrial drainage in a more stable, cost-effective, and efficient manner. The cleaning functions effectively during heavy rains when there is a bigger volume of flowing water containing trash and a higher velocity. The probability of workers having illnesses or becoming poisoned as a result of massive volumes of garbage and chemicals will be reduced. This project could be finished with a complete allocation of economic resources, machines, supplies, and cash, as well as adhering to the time moving study to the letter and making our project as cost-effective and efficient as feasible with the resources we had. The semi-automatic drainage cleaning system uses an automated cleaning system that allows fluids to flow through but collects large solid wastes such as bottles and plastic. So instead of cleaning the entire drainage surface, labourers can just clean these collecting bins installed at the locations. Each collecting teeth takes 12 s to lift each waste from the bottom to the top and the amount of waste collected in the collecting bin is around 8–9 kg. The time of collecting waste is minimum. This technique has been successfully designed, manufactured, and tested, and it performs effectively.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Thermal Analysis and Energy Systems 2021.

1. Introduction

The semi-automatic drainage cleaning system is used to clean wastes from the water like polythene, bottles, etc. present in water. This can be used to overcome the problem of filtration of wastes from water and it saves them time and cost that spend on cleaning the drainage. More solid ingredients wastes reach this point. Semi-automatic drainage cleaning system is used to remove solid waste from drainage. This machine is extremely simple to install at any drain point. It was created in such a way that it allows water to flow through it while collecting all solid waste and depositing it in a group in the collecting bin. This may be used to tackle the problem of waste filtering from water while also saving time and money on drainage cleaning. As the number of companies in the environment develops, so does the amount of rubbish they produce, will also increases. This water combines with other water that people consume, and already know that this water is hazardous to their health. As a result, to avoid these issues the collector bin collects the wastes floating in the water.(See Table 1.).

A mechanical semi-automated drainage water cleaner was installed, in the collector's teeth lift the waste material is deposited in a storage or collection bin [1]. The waste products are taken from the collecting container once it is full. The drain flow is now efficient due to frequent filtration of waste. Comparison of the two systems, which is mechanical and human labor, was done [2]. The main factors for the comparison made by him as time, economy, and efficiency. The time required by the system will be less and also be more economic. Manual labor is more tiresome work and is a more time-consuming process. Use of Direct Current Motor (DCM) in which the motor, chain and sprocket, belt and pulley, shaft, collector, and lifter are among the components [3]. The output shaft of the motor begins to rotate once electricity is applied to it. With the use of a belt and pulley arrangement, the motor's main shaft and output shaft are connected. The main shaft is where the chain and sprocket are mounted. The chain also holds the lifter bucket. The lifter moves in lockstep with the chain once it

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Table 1
Materials Used in the work.

Sl.No.	Description	Quantity	Material	Specification
1.	Frame	1	Mild Steel	Combination of Iron and Carbon
2.	Shaft	1	Mild Steel	Shaft Diameter = 12 mm
3.	Bearing	4	Stainless Steel	Ball Bearing
4.	Chain Drive	2	Stainless Steel	05b3 R-940
6.	Sheet Metal	1	Galvanized Iron Sheet	Zinc Coating
7.	Dc Motor	1	Electrical	Wiper Motor
8.	Battery	1	Electrical	Lead - Acid Battery

begins to rotate. This bucket collects all solid garbage, such as plastic bottles, cans, and carry bags.

The system is made up of sensor nodes that are connected via a wireless sensor network [4]. The suggested system is a low-cost, low-maintenance, IoT-based real-time system that sends a message to the managing station if a manhole's threshold values are exceeded. This technique lowers the risk of death for manual scavengers who clean underground sewage, while also benefiting the general public. The Internet of Things is adopted in waste management system and it consist of Microcontrollers, gas sensors, liquid level indicators, and temperature sensors are among the components contained in the modules [5]. The equipment looks for blockages between the two manholes, measures the volume and depth of various harmful gases, and delivers information via alerts.

The use of an electronic bucket is introduced. It works with the help of an ARM board (ARDUINO) [6]. Normally, the garbage captured by the collector is thrown into the collector bin. This waste will be in wet form. Also, wet garbage smells more and contributes to an unhealthy environment. The electronic bucket will help to dry out the wet waste by heating the bucket. This helps to dry out the wet waste collected from the drainage pipes and converts it into dry waste. This system is used for the killing of disease-causing germs. This in turn will prevent the spread of diseases which will lead to a healthy environment. Plastic and thermocol can be separated from sewage with this device developed [7]. Develop drainage guides and other extension materials with state and federal agencies to aid in the adoption of better subsurface drainage design and management techniques. The car is controlled by the motor driver IC L293D and runs on a Raspberry Pi as the brain [8]. A python code about motor controls is pre-programmed into the Raspberry Pi. The container is monitored using an ultrasonic sensor mounted on top of it. The vehicle travels along drains in the water, collecting rubbish and depositing it in a bin.

Manually cleaning systems are hazardous to human life and take a long time to clean; therefore, to address this issue, they designed an automatic drainage water pump monitoring and control system using PLC and Supervisory Control and Data Acquisition (SCADA) [9]. The Programmable Logic Controller (PLC) and SCADA systems were designed. Construction of a river cleaning machine that can be operated remotely [10]. The motor continuously rotates the collecting plate and chain drives. Two Permanent Magnet DC (PMDC) motors are used to propel the propeller. The Radio-Frequency (RF) transmitter is in charge of the entire electrical apparatus. A method of sewage treatment took four separate steps to complete [11]. Primary removal was the initial step. Screening circular rollers and sedimentation were used to remove suspended materials and floating solids in the first stage. Secondary removal was the next step. It eliminated solids with a diameter ranging from 0 to 4 in. The third stage involved the use of oil-absorbent cellulose material for tertiary removal. Drainage water was screened to keep oil, grease, and other light materials out. Secondary (biological) treatment was the fourth stage. It securely removed dissolved organic debris that had made it past the initial treatment stage. It was carried out by bacteria that ate organic stuff.

Sewage cleaner was used to automatically remove rubbish and sewage, thereby helping to safeguard the environment from various types of environmental threats [12]. The Propeller, Cleaner, and Pan are the three primary components that make up the drainage system cleaner's effective operation. Inside the drain cleaner, a reversing mechanism that allows the drain cleaner to effortlessly operate according to the sprocket speed. The Pedal Power drain cleaner is powered entirely by mechanical energy and does not require electricity. The waste is removed from the drainage system using a pedal-operated bicycle drain cleaner. Drain cleaner works on electricity but we are replacing electricity with pedal power. In our project is to design and fabricate a semi-automatic drainage cleaner to easily remove the drainage waste. Its construction is lightweight, compact, and easy to operate.

The novelty of the work is the semi-automatic drainage cleaner will operate effective in rural and slum locations. As drainage are unhygienic in slum areas and cause serious problems, where this project in certain locations can protect people's health and maintain the area clean. Considering that drainage and sewage pathways are open in India, this idea or method could be very useful in cleaning the drainage. The system is very low in cost and also incorporated with components which are often used in bicycle assembly. The objective of this study is to develop a semi-automatic drainage cleaning machine for collecting wastes like polythene, bottles, trash cans, etc. The purpose of this suggested method is to minimize or eliminate the problem encountered while humans cleaning manually.

2. Design calculation

This section discusses the design calculation of a semi-automatic drainage cleaner system [13–15]. Let's assume,

$$\text{Speed (N)} = 30rpm$$

We suppose the weight of the garbage =.4*kg*

$$\text{Belt length} = 390mm$$

FoS = 1.5.

$$Force = 39.24N$$

$$Torque = Force \times Distance \tag{1}$$

$$= 12.5568N - m$$

$$\text{Therefore, maximum Torque} = Torque \times FoS \tag{2}$$

$$= 18.8352N - m$$

Now,

$$Power = \frac{2 \times \pi \times N \times T}{60} \tag{3}$$

$= 59.1725 watts.$

Therefore,
Selecting of motor 84 W so losses can be avoided.
Voltage(we selected) = 12 Volt;
Current = 7 *amp*.
Preferred transmission ratio i,
For i = 1,
where Z1 - number of teeth on sprocket,
a - centre distance,
p - pitch.
Z_1 = 30 from DDB (7.74).
a = (30 to 50)p.
for maximum pitch,

$$p = \frac{a}{30} \tag{4}$$

$= 13.23 mm$

for minimum pitch,

$$p = \frac{a}{50} \tag{5}$$

$= 7.94 mm$

From average, the pitch = 9.525 mm.
Thus, the chain selected is 05B3 R-940.
Diameter of sprocket (d).

$$Diameter\ of\ sprocket(d) = \frac{p}{\sin\left(\frac{180}{z_1}\right)} = 91.12 mm \tag{6}$$

3. Modeling and methodology

Only water goes through the lower basement after the gadget is placed across a drain. Lifters attached to the chain hoist floating waste such as bottles, plastic cans, and covers. The sprocket wheel, which is operated by the motor, spins with the chain. The motor receives its energy from an electrical source. When the engine is turned on, the chain begins to circulate, causing the lifter to rise. Lifter teeth lift the waste material and deposit it in a storage or collection receptacle. The waste products are taken from the collecting container once it is full. The motor begins to revolve when the motor switch is turned on or when the current is supplied to the motor. The shaft's rotating motion is transmitted to the upper shaft through a chain and sprocket system mounted on tapper bars. Using sprockets and chains, motion is conveyed from the top shaft to the bottom shaft. The teeth that lift waste from the drainage system are inserted or fastened between two chains on the top and bottom shafts. The dust bin, which collects all of the waste, is mounted on vertical bars behind the chains. Between the chains and the dust bin will be a mesh that acts as a barrier, preventing the trash from floating away. When the motor is turned on, the two shafts begin to rotate. As a result, the teeth begin to spin. When the teeth penetrate the water while revolving, they lift the waste that is present in the water with them. During rotation, it drags the waste with it and eventually deposits it in the dustbin [16].

Initially, the current system's flaws were recognized, and associated journals were gathered. After that, the idea was screened and the system's attributes were gathered. Finally, a model has been developed, examined, and the findings have been documented. Fig. 1 shows 3D of semi-automatic drainage cleaner. Fig. 2 shows that the flow chart of fabrication of semi-automatic drainage cleaner. Using CREO Software version 7.0, drawn a 3D view of Semi-Automatic Drainage cleaner shown in the Figure. In 3 Dimensional view, have designed components like DC motor, sprockets, shaft, frame and assembled them altogether. The project is designed in an efficient manner to control waste disposal, regular drain filtering, and solid waste removal in order to avoid drainage blockages and promote continuous drainage water flow and reducing the threat to human health.

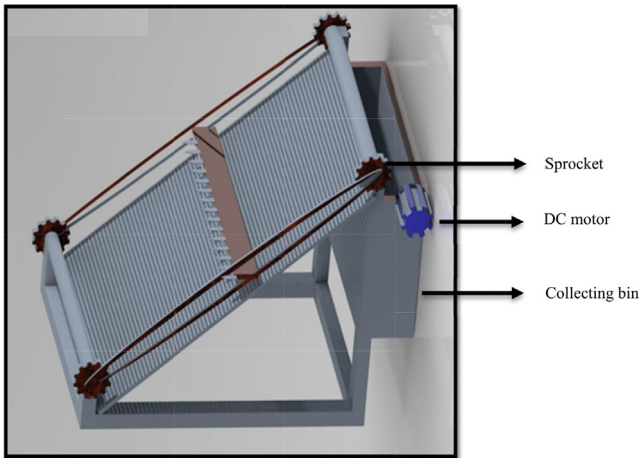

Fig. 1. 3D of Semi-Automatic Drainage Cleaner.

4. Experimental set-up

Through its mechanical design and operation, the drainage cleaning machine assists us in cleaning little or large amounts of sewage. This machine is made up of various components such as a motor, battery, shaft, lifter, and collecting box. When we turn on the power to this machine, the motor kicks in and turns the shaft. The conveyor belt linked to the shafts revolves as the shafts rotate. As the conveyor belt rotates, the two lifters that are attached to the conveyor at half-length begin to revolve as well [17]. Fig. 3 shows fabricated model of semi-automatic drainage system. When one lifter completes one round from down to up, it collects all garbage such as waste bottles, plastics, tins, and so on. The grid deposits it in the back-attached collection box. Garbage collection will continue at the current rate. This device is put across a drainage system so that only water flows through the lower grid, and waste such as bottles and plastics that float in the drain are lifted by the teeth of a lifter attached to a conveyor. This conveyor is connected to motor-driven shafts.

5. Results and discussion

This study can safeguard people's health and keep the region clean in society since drainage is unclean and causes big problems. Separation of these solid wastes aids in solid waste treatment and conversion to degradable trash. The setup is light in weight and can be installed at any drainage system intersections which are frequently blocked due to solid wastes. Fig. 4 indicated the collecting waste with respect to time. Each collecting teeth takes 12 s to lift each waste from the bottom to the top and the amount of waste collected in the collecting bin is around 8–9 kg. The time of collecting waste is minimum.

In Semi-Automatic drainage cleaner, for fabrication purpose mild steel is used which is easy for cutting, bending and welding purpose and improve the lifetime of the chain drain, sieve holes are attached along the frame which allows only the water to flow through it. The Semi-automatic drainage cleaning system is a social

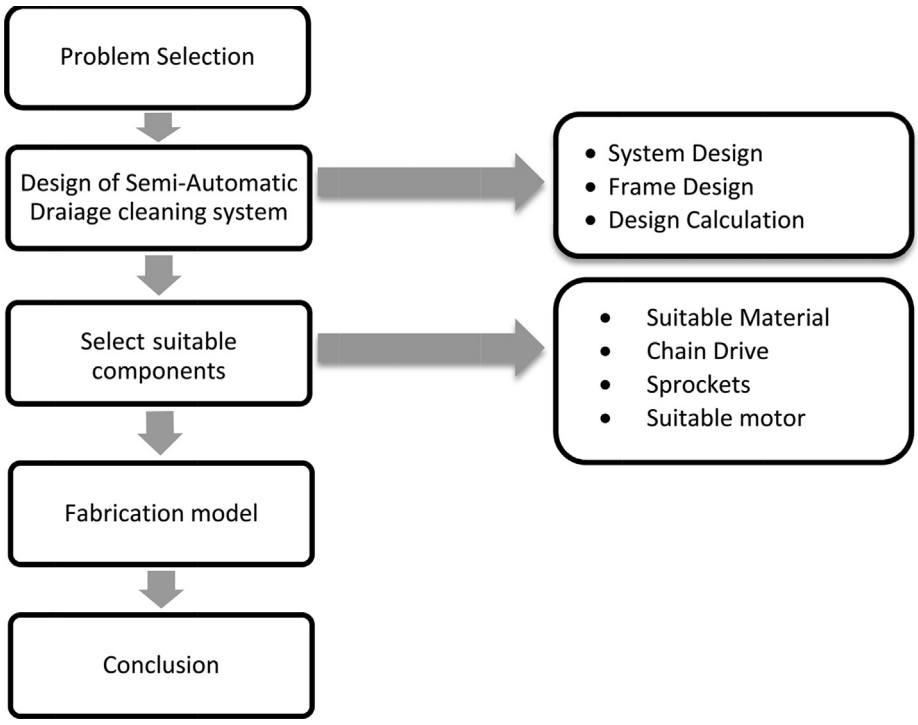

Fig. 2. Flow Chart of the Fabrication of semi-automatic drainage cleaner.

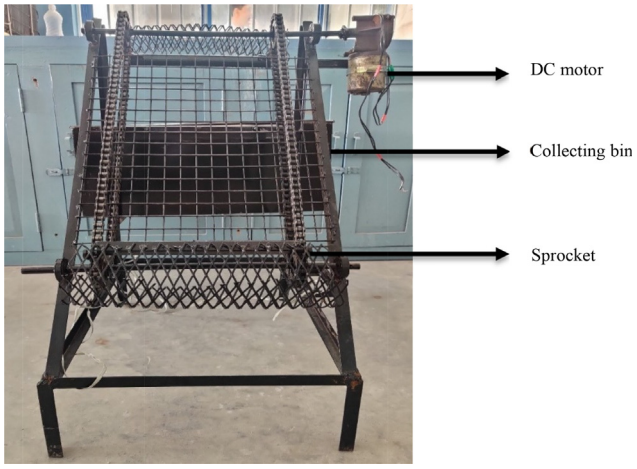

Fig. 3. Fabricated Model of Semi-Automatic Drainage System.

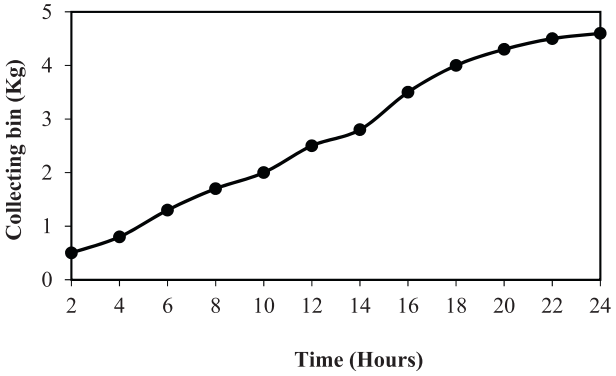

Fig. 4. Collecting waste with respect to time.

benefit initiative project in which far better method for keeping the drainage clean, elimination of manual cleaning by the labour, paving the way for a cleaner and safer environment is achieved. The following conditions are examined during the experiment. They are uniform water flow rate, depth of the channel is 2 foot and height of the channel is 4 feet, uniform waste disposal rate, lifter speed, and motor speed are constant. Each lifter takes 12 s to lift each object from bottom to top. In the waste collection bin, there are almost 10–12 kg of waste are collected. The machine is inexpensive, and it only takes 12 V of power. A 12 V DC motor is equipped to run the system which is inexpensive when compared to the other systems. There are no concerns of electrical shock because the system uses a low-power electrical source such as a 12 V DC motor. The system's construction also includes a simple bicycle mechanism that poses no risk to human health or society. The limitation of the work is the 12 V DC motor requires continuous power to run and the waste in the collecting bin should be cleaned on a regular basis. Rusting of the frame occurs due to the mild steel.

6. Conclusion

This study summarizes residential and industrial drainage in a more stable, cost-effective, and efficient manner. The cleaning functions effectively during heavy rains when there is a bigger volume of flowing water containing trash and a higher velocity. The probability of workers having illnesses or becoming poisoned as a result of massive volumes of garbage and chemicals will be reduced. This project could be finished with a complete allocation of economic resources, machines, supplies, and cash, as well as adhering to the time moving study to the letter and making our project as cost-effective and efficient as feasible with the resources we had. This technique has been successfully designed, manufactured, and tested, and it performs effectively.

CRediT authorship contribution statement

P. Saji Raveendran: Writing – review & editing. **S. Panith Malai:** Conceptualization, Methodology. **R. Naveen raj:** Visualization, Investigation. **V. Naveen:** Visualization, Investigation. **J.S. Binoj:** Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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