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Integration of IoT and Robotics for Smart Industrial Waste Management: Design and Implementation of an Automated Collection System

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Abstract

All types of drainage issues are resolved by the Automatic Industrial Hazardous and Waste Collecting Machine, which also encourages blockage-free drains and a constant flow of drain water. Sewage water needs to be separated in the present period due to pollutants present in sewage to maintain environmental cleanliness. Both humans and the environment are severely harmed by the garbage and pollutants generated by industry and the areas around cities. Using auto mechanism technology, our proposed system cleans and controls the industrial waste. Restoring manual trash disposal in sewage treatment facilities and other sectors is the project's cornerstone. This will be an effort to lighten the workload for the labor-intensive manual workers who remove solid garbage. When these machines take the place of people in the process of cleaning the solid waste from industries, the trend of mortality will clearly be declining. This invention is inherently technological, enhancing the social dignity of the manual laborers in sewage plants. This will be a legitimate move towards advancing one of the objectives of sustainable development. 'A life of dignity for all', this study presents an agglomeration of socio-economic development, scientific temper and innovation which is stepping towards sustainable development.

Keywords: Planking, liquid sewage, suistanable development, robotics, industrial waste

INTRODUCTION

The world is currently dealing with a serious trash crisis brought on by rapid economic expansion, population development, poor city design, corrosive corruption, and governmental dysfunction. The gift-attempted and -examined garbage series strategies have shown to be ineffectual in testing thus far. Additionally, the global community these days is advocating for more clever ways to get past the trouble of the garbage series. Commercial, natural or deliberate evacuation of surface and subsurface water from a region is known as hazardous waste. Most agricultural soils have adequate natural water resistance ability to prevent severe water logging, which is anaerobic conditions that damage root growth. However, many soils require water absorbency to increase productivity or control water supplies. The drainage and sewer systems of the Indus Valley Civilization were sophisticated as shown in Figure 1. In the great cities of Mohenjo-Daro and Harappa, every home had access to drainage and water systems. The main roadways were dotted with covered gravity drains that received wastewater. Hollow-pipe drainage is credited to Sir Hugh Dalrymple, who passed away in 1753, in the 18th and 19th centuries. By encouraging waste management and clearing debris

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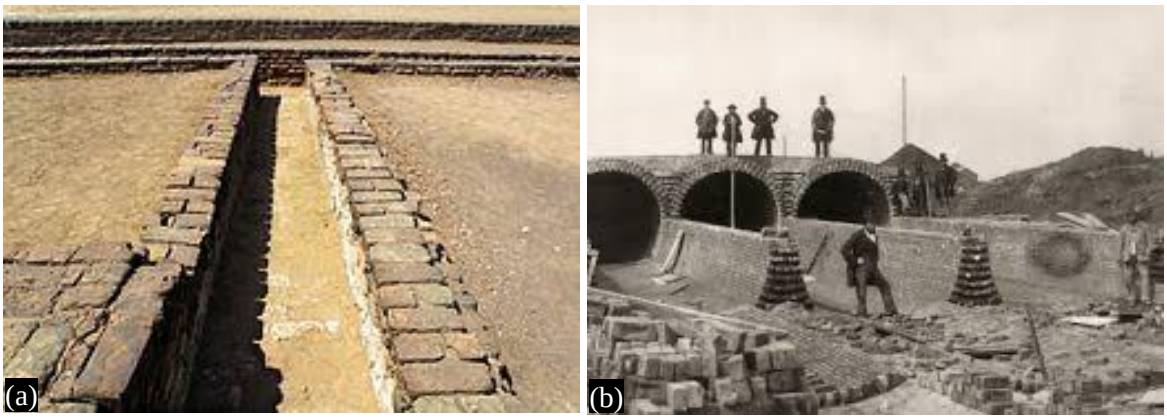

Figure 1. Sewerage and drainage systems in the period of Indus Valley Civilization.

from the drainage system, the drainage system cleaner is a device that helps safeguard the environment against various environmental threats. If these wastes are not removed, they settle in residential areas where they are burned, contributing to climate change; alternatively, they clog drainage systems, resulting in flooding. Even while automation is becoming increasingly vital in all industrial applications, properly disposing of sewage from commercial buildings and businesses is still a difficult issue. The drainage cleaning system is suggested as a solution for immediate issues. As companies continue to grow, there is an urgent need to find solutions to the sewage water issues in order to reduce the amount of sewage that these industries are producing that is affecting the environment. Both people and the environment are seriously harmed by the solid waste that is generated by industries. We all know how important water is to our existence we can see it flowing through a drain that is clogged with trash like bottles and polythene.

Hand Scavengers

Hand scavengers are used in the traditional way of disposing of sewage trash when they enter the maintenance pit. An estimated, 1.24 million of the nation's scavengers are actively engaged in keeping our environment clean. The most common instruments used by manual scavengers are buckets with handles and sacks within. The employee then physically transports the rubbish to the disposal locations using just their own hands. Here, gases including hydrogen disulfide, carbon (IV) oxide, ammonia, and methane are exposed to scavengers. Long-term exposure to hydrogen disulfide can cause asphyxia resulting in death.

In building projects, drainage is the responsibility of the civil engineering department. They began construction activities on all the roads, street gutters, drainage, culverts, and sewers based on the blueprints. He or she will lay out all the levels required for each one of the aspects during the construction process. Water is intercepted at gullies (points) by point drainage. To link gullies to drainage pipes below the surface of the ground, significant excavation is needed. Deep ditches need to be supported by planking, strutting, or shoring channel drainage, which collects rainwater along the whole channel's length. The most common materials used to create channel drainage are composites, steel, concrete, and polymers. Compared to point drainage, channel drainage has a higher interception rate and typically requires significantly less deep excavation. The main theme of the study is that cleaning of industrial drains/channels has always been a problem. Labors cleaning sewages leads to high risk of infections and enough to cause dreadful disease.

When bottles, plastics, and other similar solid debris are disposed of in gutters, the flow of sewage becomes narrowed and finally blocked as shown in Figure 2. This frequently results in overflow. To address these contemporary gutter jamming problems, we are offering a completely automated drainage cleaning system as shown in Figure 3. The system makes use of an automatic drain cleaning system that allows drainage water to pass through it while collecting and discarding solid debris, such as bottles and plastic, in a collecting bin.

Figure 2. Coagulation of drainage with plastic waste.

Figure 3. Automatic drainage cleaner.

EXISTING SYSTEM

Brijesh *et al*. provide a simple, safe, and dependable solution to the widespread issue of ineffective waste disposal. Due to factors including corrosive corruption, overcrowding, bad urban planning, fast economic growth, and governmental dysfunction, the world is currently experiencing a serious waste crisis. The tried and true trash collection procedures of today have not worked as of yet. Additionally, modern society is searching for more clever solutions to the rubbish collecting issue. Our product's primary consumers are house helpers, corporate employees, and pavement sweepers, among others. The semi-automatic waste collection device for walkways is presented in this study. The device is constructed with a battery-operated metallic base [1]. The machine can be operated mechanically (push or pull) or remotely. The device is intended to gather trash from public areas such as parks, schools and colleges, as well as from pavements and beaches that are primarily made of cement. The machine is made up of several steel plates fastened to the axis and a roller with brushes. When the motor is turned on, it rotates at a fast speed, pushing solid waste into the conveyor belts because of the conveyor belts. After that, this is transferred to the bin fastened to the body's back. We can take the drum out and empty the gathered waste after it is filled [2].

Ramteke *et al*. focuses on offering a simple, safe, and reliable solution to the common problem of ineffective trash disposal [3]. Ramesh *et al*. used an automated method to clean drains instead of using human labour [4].

Babu and Jayakumar's device eliminates solid garbage and then removes liquid sewage by sucking it away again through their proposed model. With the aid of claws, the sewage cleaning machine's main purpose is to gather, move, and dispose of solid waste in the waste bucket. Papers, polythene bags, and empty bottles are examples of solid trash that ends up in drains. With the use of a model and this driving system, the drainage was regularly cleaned, removing solid waste and disposing of it in a waste bucket [5].

Even though mechanical drainage is essential to all industrial applications these days, properly disposing of sewage from businesses and industries remains a difficult undertaking. Drainage pipes are used for disposal, and regrettably, while clearing obstructions in the drainage system, human lives may occasionally be lost [6]. We developed our project to make effective use of this "mechanical semi-automatic drainage water cleaner" in order to control waste disposal and provide regular waste filtration in order to solve this issue and save human life. Hasan *et al*. designed a system implemented to clean and control the drainage level in order to overcome the challenges associated with manual drain cleaning [7]. Their project was created with this ineffective method of waste disposal regulation in mind, along with routine waste filtering.

Usage of Mechanical Drainage Cleaner

The idea put out in the research study is to use a mechanical drain cleaner in place of manual labour to clean drains. The primary users of our device would be domestic helpers, company employees, and pavement sweepers, among others. It is possible to control the device's movements remotely or mechanically (by pushing or pulling). The gadget is intended to collect trash from public areas such as gardens, halls, and institutions, as well as from beaches and typically sealed pathways. Collecting bin with net is shown in Figure 4.

The project's primary component is the motor, which consists of a high force, low power motor and a conveyer with a filter connected to its motor chain. This motor rotates to collect sand waste and transfers it to a storage bucket. It is an accountable full driving mechanism. Therefore, the trash from the bucket is transferred to the utilisation method, minimising pollution and also requiring beach cleaning. These wastes in the water cause blockages in the drains. Even though mechanical equipment is essential to all industrial applications these days, properly disposing of sewage from businesses and commercial buildings is still a difficult undertaking. Drains are used for disposal, and regrettably, while clearing obstructions in the drainage systems, human lives may occasionally be lost. Additionally, the government overspends on drainage cleaning [8–10]. Automatic drainage cleaner equipment is shown in Figure 5.

The main components of automatic drainage cleaning system:

1. Frame body,
2. Collecting tank,
3. Collecting jaw or bucket,
4. DC motor,
5. 12 V battery,
6. Iron wire mesh,
7. Roller chain,
8. Sprockets,
9. Shaft,
10. Ball bearing,
11. Conveyor belt,
12. Rollers, and
13. Nut and bolts.

Various parts of drainage cleaner equipment designed by CATLA software using numerous components have been shown in Figure 6(a)–(c).

Figure 4. Collecting bin with net.

Figure 5. Automatic drainage cleaner equipment.

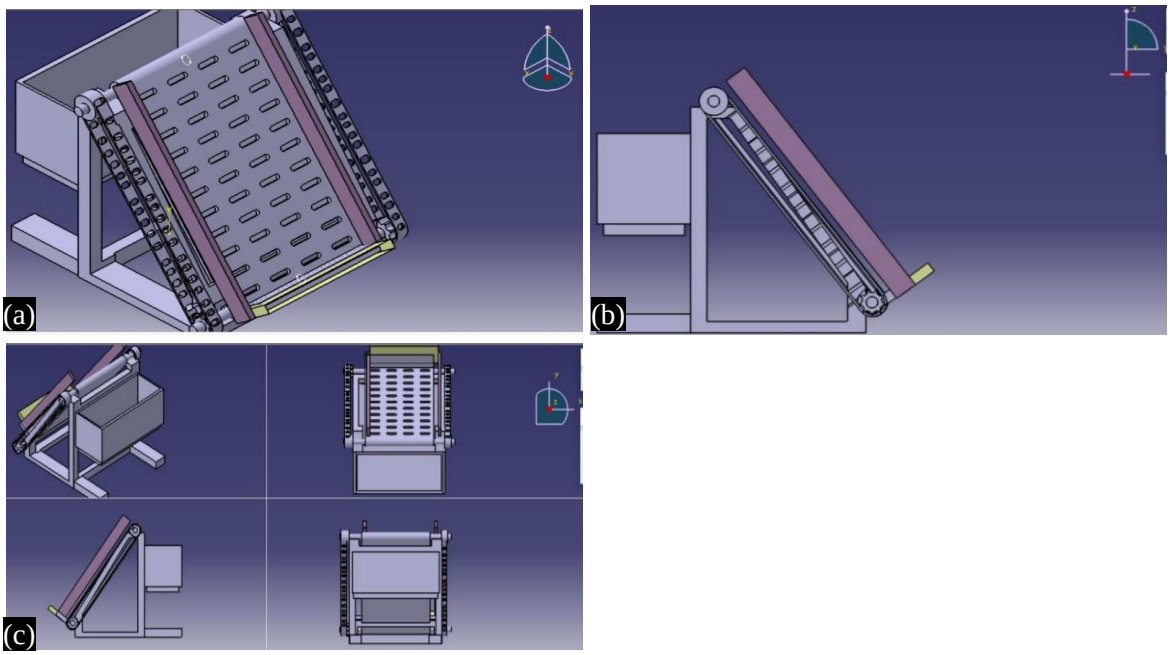

Figure 6. (a)–(c) parts designed by using CATIA software.

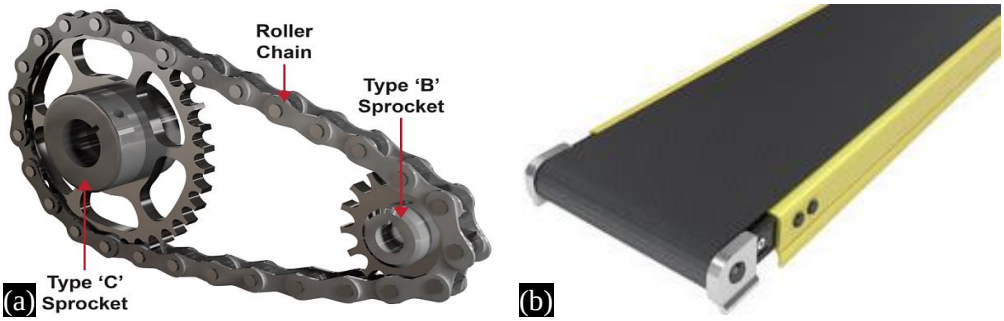

Figure 7. (a) chain drive mechanism, (b) conveyor systems.

The Automatic Industrial Hazardous Waste Collecting system is based on two mechanisms.

1. Chain drive mechanism, and
2. Conveyor systems.

One method of moving mechanical power from one location to another is chain drive as shown in Figure 7(a). Power is frequently transferred to a vehicle's wheels using it, especially on bicycles and motorbikes. In addition to cars, a broad range of other machinery also employs it.

One popular form of mechanical handling equipment for moving things from one place to another is a conveyor system as shown in Figure 7(b). Applications involving the conveyance of large or heavy goods make conveyors extremely helpful. Conveyor systems are highly common in the material handling and packaging sectors because they facilitate the rapid and effective transportation of a wide range of commodities [11]. The frame body of machine is shown in Figure 8.

Any rotational electrical machine that transforms electrical energy from direct current into mechanical energy is called a DC motor. The most often used kinds depend on the forces generated by magnetic fields. Almost all varieties of DC motors contain an internal mechanism, electromechanical or electronic, that allows the motor's portion to periodically reverse the direction of current flow. The cathode, or positive terminal of a battery, produces electricity, and the anode, or negative terminal, does the same. Electric motor with sprockets attached using a 12 V battery is shown in Figure 9.

Figure 8. Frame body of machine.

(a) (b)

Figure 9. Electric motor with sprockets attached using a 12 V battery.

Table 1. Various roller chains standard sizes with their strengths.

ASME/ANSI B29.1-2011 Roller Chain Standard Sizes				
Size	***Pitch***	***Maximum roller diameter***	***Minimum ultimate tensile strength***	***Measuring load***
25	*0.250 in (6.35 mm)*	*0.130 in (3.30 mm)*	*780 lb. (350 kg)*	*18 lb (8.2 kg)*
35	0.375 in (9.53 mm)	0.200 in (5.08 mm)	1,760 lb (800 kg)	18 lb (8.2 kg)
41	0.500 in (12.70 mm)	0.306 in (7.77 mm)	1,500 lb (680 kg)	18 lb (8.2 kg)
40	0.500 in (12.70 mm)	0.312 in (7.92 mm)	3,125 lb (1,417 kg)	31 lb (14 kg)
50	0.625 in (15.88 mm)	0.400 in (10.16 mm)	4,880 lb (2,210 kg)	49 lb (22 kg)
60	0.750 in (19.05 mm)	0.469 in (11.91 mm)	7,030 lb (3,190 kg)	70 lb (32 kg)

A chain is a sequential arrangement of linked components, or links, usually composed of metal. A chain's general characteristics are comparable to those of a rope, being linear, stiff, and load bearing in tension, but flexible and bent in compression. There can be two or more links in a chain. The design of chains can be categorized based on how they are intended to be used. Various roller Chains Standard Sizes with their strengths are shown in Table 1.

A sprocket or sprocket-wheel is a profiled wheel with teeth, or cogs, that mesh with a chain, track or other perforated or indented material. In general, any wheel that has radial projections that contact a chain that passes over it is referred described as a “sprocket” as shown in Figure 10. Basic parts of roller chain have been shown in Figure 11 [6, 7]. It is not the same as a gear since the sprockets are never directly meshed, and it is not the same as a pulley because the sprockets have teeth, and the pulleys are smooth.

Figure 10. Sprockets.

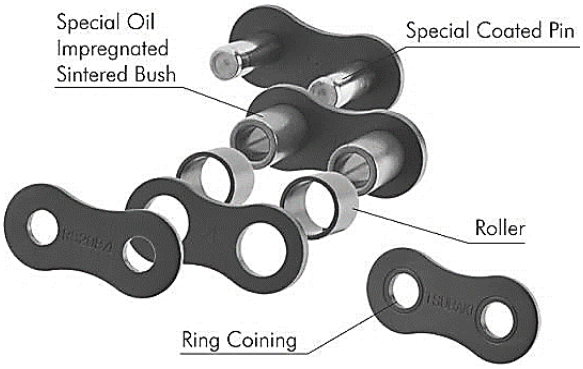

Figure 11. Basic parts of roller chain.

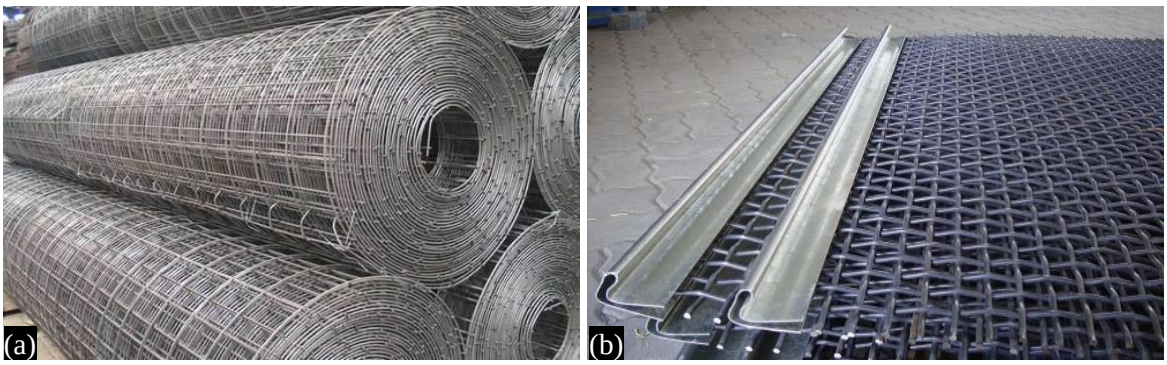

Figure 12. (a) iron mesh (rolled), (b) iron mesh (linear or straight).

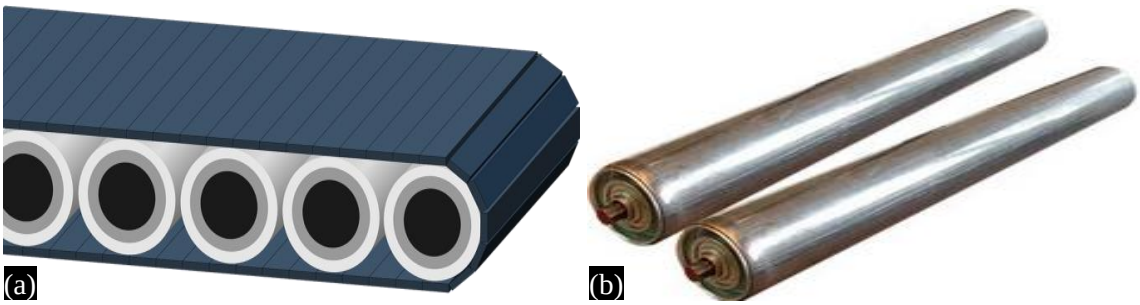

Figure 13. (a) belt conveyor system, (b) transmission Shafts.

A mesh as shown in Figure 12 is a barrier consisting of interwoven fiber, metal, or other ductile or flexible materials strands. Because it is made up of numerous interwoven or linked strands, a mesh resembles a web or net. It safeguards the floating waste as it flows through the apparatus.

Transmission shafts as shown in Figure 13(b) are used to transmit power between the source and the machine absorbing power, e.g. counter shafts and line shafts. Machine shafts, such as the crankshaft, are an essential component of the machine itself. A ball bearing is a kind of rolling element bearing in which the bearing races are kept apart by balls. A belt conveyor system is made up of two or more pulleys, also called drums, around which revolves an infinite conveyor belt loop that serves as the carrying medium as shown in Figure 13(a).

Fabrication Process

Arc welding is a technique for joining metal to metal by melting the metal with the help of electricity. The melted metal then cools and forms a bond with the other metal. This kind of welding melts the metal at the welding spot by creating an electric arc between an electrode and the base material with the help of a welding power supply.

Working Principle

The device is positioned above the deplete to let water flow through lower grids and waste products such as wood, paper, bottles, textiles, and hazardous industrial materials. Teeth that are connected to the chain limit the flow in deplete. This anchor is appended to equip driven by motor. Motor is beginning to bind is begun to circle. Making teeth to lift squandered material put away in tank. Teeth attached to a chain raise objects that are floating in the drain. A gear that is powered by a motor attaches this chain. When the motor operates, the chain begins to rotate, lifting the waste materials with the teeth and storing them in the waste storage tank. The automated mechanism is basically designed to filter out the solid waste of the running drains and hence removing the possibility of any blockage of the flowing wastewater. The component that generates power (rotation) via hydraulic power is called a turbine, which in turn powers the chain mechanism. The chain mechanism is powered because of the power generated by the turbine being transferred from the turbine shaft to the mechanism driving shaft via the sprocket-chain arrangement. The wire mesh filter installed on the chain mechanism only collects solid waste, allowing liquid waste to pass through the mesh.

RESULTS

Mechanical Drainage Cleaner, in association with IOT and robotics, is a better option for hazardous waste collection as compared to manual labor collection. To determine the various sizes of solid waste we are working with, the mesh hole sizes can be changed. An angle adjustment is being made to the system to hold the solid waste. After the solid trash has been gathered, it is stored in a storage box that can be cleaned to get rid of the waste. Motor can be used to rotate chain drive. This engine is battery-operated and may be charged using a solar plate. The device is placed across the drain to allow only water to pass through the bottom grids. This prevents the passage of hazardous materials, plastic debris, and other rubbish.

CONCLUSION

Water, as we all know, is essential to human life; consider the water flowing down a drain that is clogged with waste materials like bottles and polythene. These wastes in the water cause blockages in the drains. Drains are used for disposal, and regrettably, while clearing obstructions in the drainage systems, human lives may occasionally be lost. In order to solve this issue and preserve human life, we have designed a Trash Removal System. Our concept was created to effectively use this to regulate waste disposal and provide regular waste filtration. This device draws power from the battery.

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