Invention Disclosure Details

1. Please provide a suitable title for your invention.

A) IoT-based Smart Drainage Cleaning System for Sustainable Waste Removal

2. Please elaborate on the problem being solved by your invention. Please specify the actual problem in the existing product or process.

A) Problem Statement:

1. Generally, most of the household waste and industrial waste gets disposed of into drainage systems. This disposal includes solid waste too which gets accumulated in drainages and is referred to as debris generally. Proper management of this type of waste in drainages is important to prevent blockages.
2. Many rural areas do not have an adequate amount of garbage bins on the roads for people to dispose of their waste. So people throw the garbage either on the vacant land or on the roadside. Usually, workers from municipalities clean the drainages and the trash on the road which involves direct contact with the waste which is not hygienic.
3. This may lead to infections, allergies and health problems and as the waste continuously accumulates in drainages day by day, workers need to continuously clean the drainages which only increases the exposure to pathogens, toxic gases from decomposing organic matter and chemicals from industries which leads to health hazards.
4. This invention provides IoT-integrated automated machines to collect the trash on the roadside and clean waste in the drainages can help reduce human contact with the waste to a great extent which in turn decreases the transmission of the disease-causing pathogen. These machines are embedded with different sensors to detect obstacles to avoid them and to detect the waste materials to collect them into trash bags or bins and they can work continuously. This improves hygiene and decreases health hazards.

Drawbacks in the traditional processes:

1. Most of the existing products need to be under the supervision of a human continuously like controlling the machine with a remote control for directing the path, collection of waste etc. And there are not many models using sensors for detection. Even if there are products that need not be controlled continuously and are sensor-embedded, they only concentrate only one aspect which is either the drainage cleanup or collecting the waste on the road [1]. The comparison between the traditional processes and the proposed method is illustrated in **Table 1**.
2. Sensors of the existing products that operate in the drainage might be damaged when there is an overflooding of drainage water due to various reasons.[5].

3. Please detail the solution being provided by the invention to overcome the problem. Please provide a schematic diagram and its description if required.

A) Recognizing the importance of these challenges, we attempt to come up with a novel design involving two separate machines. The two distinct machines that make up the prototype design each have unique characteristics and purposes. It is developed to traverse roads and efficiently lift drainage waste from the drainage system.

Out of the two machines used in the design, one of the machines traverses on the road as shown in **Fig. 2** and the other machine is partially submerged in water as shown in **Fig. 1**. Both of these machines are connected through an extensible rod.

Case 1:

Functionality:

The machine partially submerged in water as shown in **Fig. 1** is equipped with a rotator consisting of three blades in a corner shovel-based structure. The machine is propelled forward inside the water with the assistance of motors and these three rotors rotate while being partially submerged in the water, collecting the garbage only. However, they drain the water and throw the garbage into a slanting rod-like structure that is attached to this machine and is also connected to the machine on land, where it is finally dumped into the bucket-like structure that is a part of the machine on land.

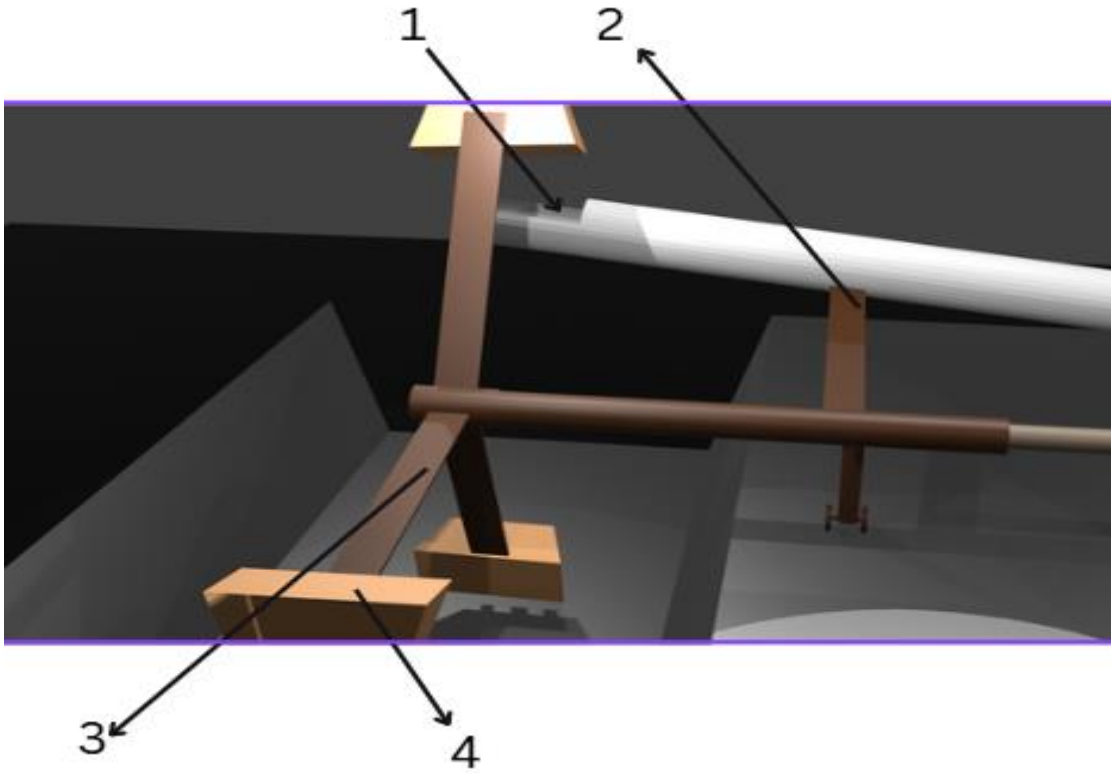

Fig:1 Schematic View of the Proposed System

1- The location where the blades throw the waste into the pipe.

2- It is the support for the pip to handle the weight of waste which is been thrown.

3-The rotator which helps out to lift the waste from drainage. It rotates through the motors.

4-The Blade which looks like a shovel placed for lifting the waste. The shape of that will be thrown back into the pipe while it rotation.

The machine that traverses on land as shown in **Fig. 2** is powered by a voltage power supply and has motors that help it travel on the road. This machine consists of sensors that help it with the identification of obstacles and change its path when it detects heavy obstacles and uses the extensible rod to extend the distance between two machines so the machine on land can change its path while the machine that is semi-submerged in water will stay in its original path.

This machine on land also uses a vacuum that uses suction to pull all the solid waste materials on the land beside open drainage and uses a filter to drain any liquid if it sucks any wet waste material. This machine also consists of a bucket-like structure for the storage of all the garbage collected before disposal as shown in **Fig 4**.

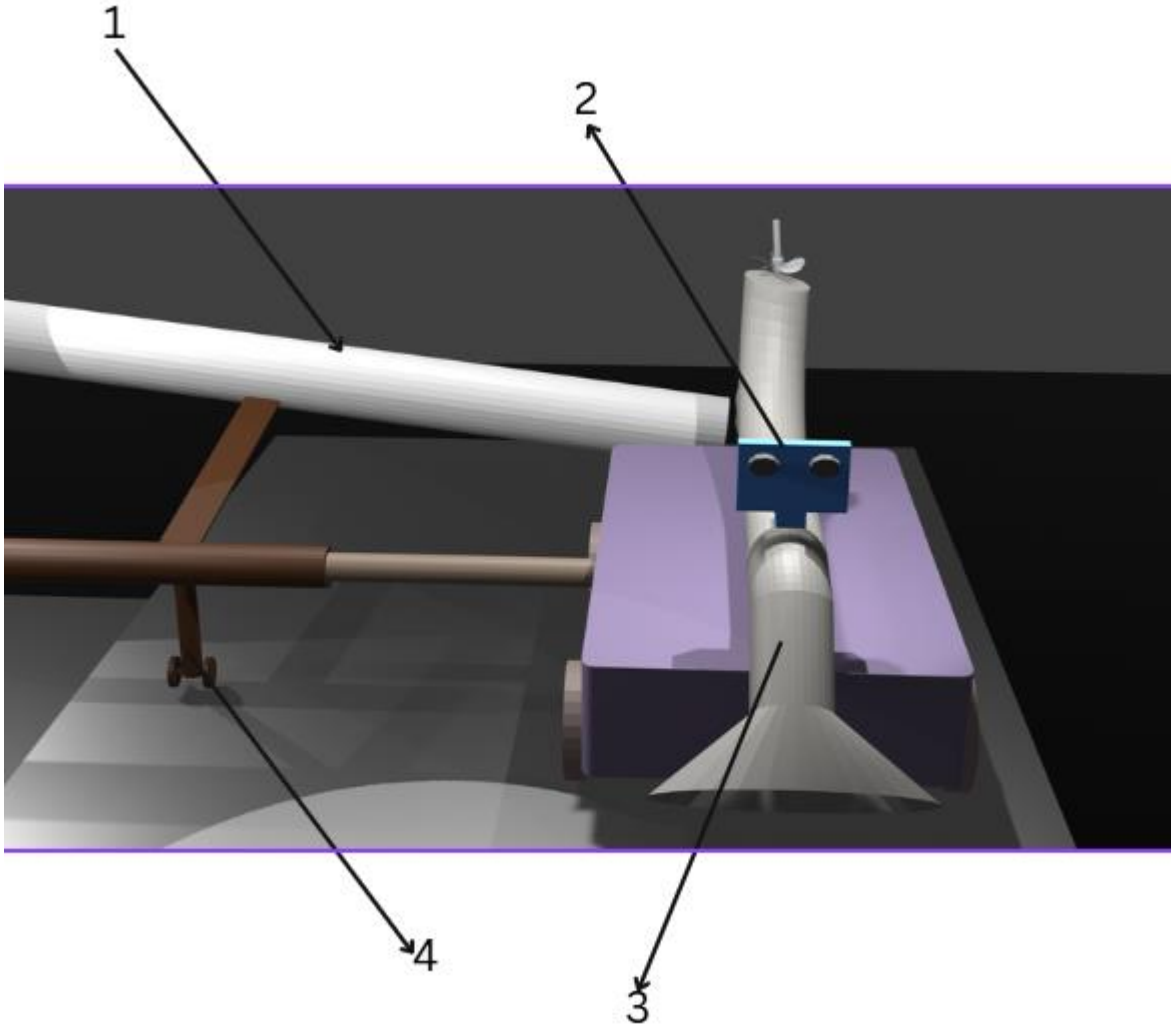

Fig Schematic view of the head of the Machine

1-The pipe which the waste flows to the bag which is attached to the machine at the back.

2-The Ultrasonic sensor is used to detect the objects that fall or keep or coming on the way. If any small object is coming on the road it moves sideways. If in case large object it stops moving but doesn't stop rotation.

3- The vacuum which is helpful in extracting the waste that is being thrown on the road. It absorbs only waste by fixing the pressure. If in case it is a sandy place we can use the sand filters or we can adjust the pressure conditions to absorb from a fixed height.
4- It is the support wheels for the rotators as well as for the pipe.

Case 2:

Operations: It makes it possible to clean the drainage system and its surroundings at the same time, greatly increasing productivity while lowering manual work and limiting exposure to potentially dangerous substances. By efficiently collecting solid waste, the integrated suction system avoids obstructions and guarantees complete cleaning.
Because of the machine's modular design, pieces may be utilized separately. For example, parts can be kept together for drainage maintenance while being separated for dust cleaning. Proactive maintenance and improved resource allocation are made possible by the real-time waste level monitoring provided by advanced sensors. This invention focuses on user safety in public areas while simultaneously improving operational efficiency because of its user-friendly interface and integrated safety elements.

User Interface

- Control Panel:
    - Simple controls for adjusting settings for each cleaning part.
- Indicators:
    - Alerts for maintenance needs or blockages.

Safety Features

- Automatic Shut-off:
    - Prevents overheating and damage to the machine.
- Emergency Stop Button:
    - Easily accessible for immediate shutdown.

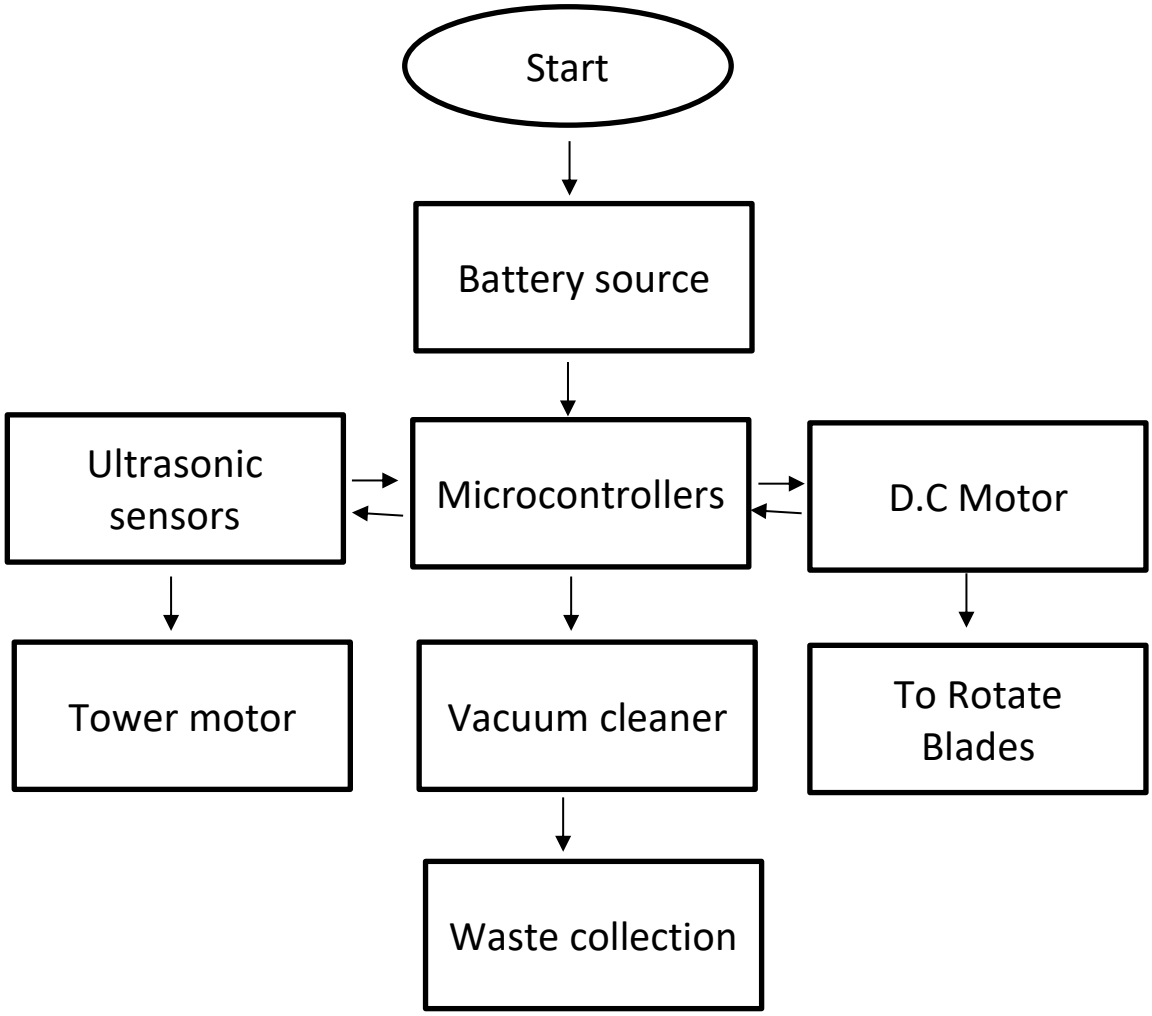

Fig : 3 Flow Chart of Machine

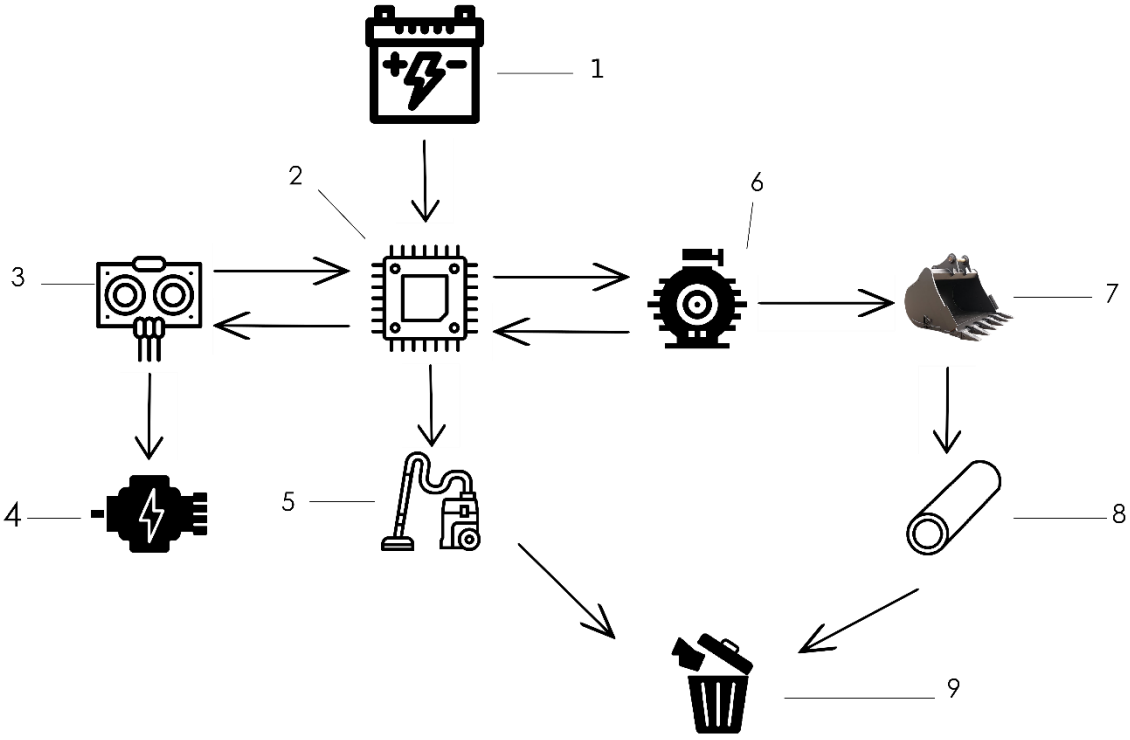

Fig:4 Workflow of Machine

1. The battery source for the machine
2. It is the microcontroller of the machine, which is Aurduino-UNO in our project. It co-ordinates with the L293N motor driver which helps from the fluctuations of current F**ig:5**.
3. It is the ultrasonic sensor **Fig: 3** that detects obstacles like big stones, human begins or any obstacle. When it detects, it moves sidewards
4. These are the wheels to escape from the obstacles, to prevent the machine from damage **Fig: 5.**
5. It is the vacuum cleaner **Fig:3**, that cleans up the road of dry waste. It throws the waste into the bin.
6. It is the HP motor that is responsible for the rotation of blades to lift the waste from the drainage.
7. The shovel which is in the shape of a JCB bucket can easily lift the waste from the drainage and throw it into a pipe. To prevent the falling waste again into the drainage a plastic sheet is attached to the shovel such that it directly falls into it.
8. The lifted waste falls into this pipe, which is fixed and slanted such that the waste slides down easily to the bin.
9. The dustbin collects the waste from the vacuum cleaner and pipe which are dry and wet wastes.

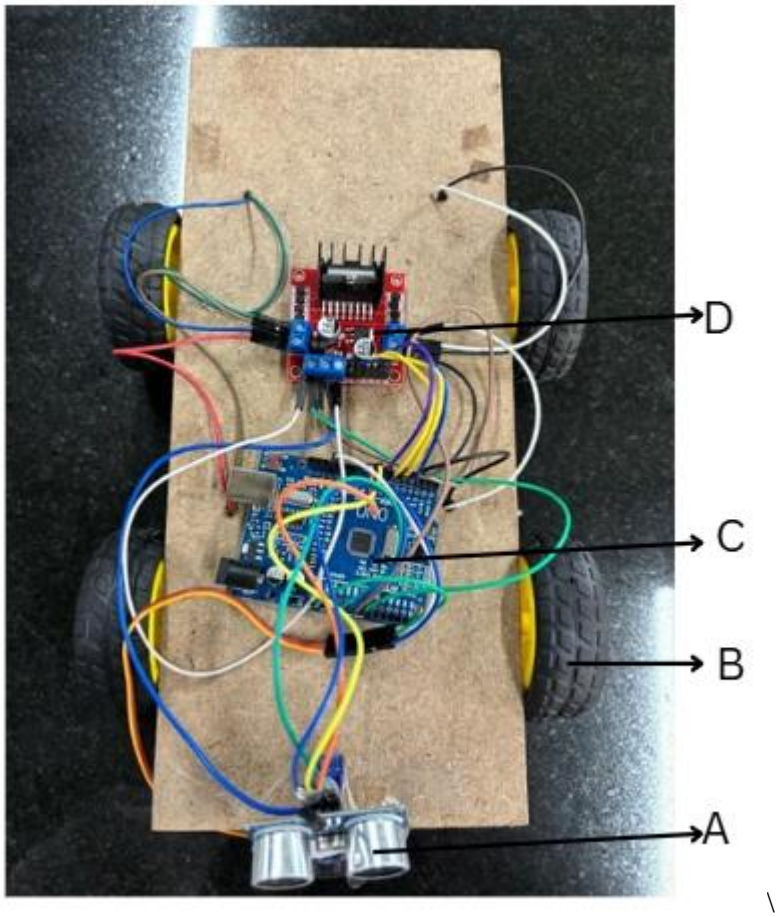

Fig: 5 Prototype

A-Ultrasonic Sensor: Obstacle detection systems use ultrasonic sensors to measure distances and identify nearby objects to prevent collisions and enhance safety.

B-Wheels: Wheels helping for moving on the road.

C- Arduino UNO: It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button.

D- L293N Motor Driver: The L293N motor driver controls the direction and speed of DC or stepper motors simultaneously.

Fig:5 is the pictures of prototypes that we had experimented for the obstacle detection. We used the Arduino as a microcontroller and L293N as a motor driver. Ultrasonic sensor as we mention earlier.

4. Please provide us with the already available solution to the problem? Please provide us with any information on the same.

A) Drainage Cleaning with arm robot: The proposed system aims to automate drainage cleaning by monitoring water levels without manual intervention. It includes a water level indicator, transmitter, receiver, and a robotic arm. The water level indicators are installed in each street drainage to monitor three levels of water: overflow, medium flow, and underflow. When the water reaches a certain level, the indicator triggers a transmitter, which sends messages regarding the water's status. The transmitter encodes these signals and transmits data via RF to a receiver located on street poles. The receiver decodes the signals and uses a GSM modem to alert maintenance workers via SMS. Additionally, the robotic arm, equipped with grippers, grinders, and suction tools, performs the cleaning tasks automatically, enhancing the efficiency of the drainage system [5].

Smart Drainage Cleaning System: The project aims to automate drainage cleaning using water level sensors, pressurized motors, and an IoT module. It consists of sensors to detect water levels, a Raspberry Pi module, an Arduino Uno, an IoT module, and a pressurized motor. The sensors identify three levels of water flow based on clogs. The first level is cleared automatically using a pressurized pump. The second level can be cleared using auto mode with increased pressure or chemicals, or manual mode. The third level, above 300, requires manual intervention. The system utilizes ATMEGA328P, Raspberry Pi 3, and pressure booster pumps to achieve its objectives [4].

Automatic Drainage Cleaning: Numerous projects are based on the conveyor belt system. This system comprises a conveyor belt and baskets designed for the collection of waste. Control of the system can be executed manually by operators or automated through the use of Internet of Things (IoT) technology. In the IoT implementation, devices such as Raspberry Pi or Arduino can be utilized, along with microcontroller-based monitoring to assess the levels of drainage waste [6][7].

Our Product	Existing Product
Time-saving and operational flexibility.	Task optimisation but takes more time to complete both tasks.
Can be cleaned both drainage and premises of it.	Only cleaning the drainage[2].
We use vacuum to clean up the waste on the road which is similar to household vacuum cleaners but on a larger scale to collect debris, litter, dried leaves etc.	Using other methods such as robotic arms, mechanical sweepers etc.
Bucket Systems for lifting the waste.	Conveyor belt operation for lifting the waste[3].
Completely Sensors equipped and no need for manpower to control it.	Some need to be controlled remotely or by humans[1].

Table: 1 Differences

5. Please provide you with how your solution is unique and different as compared with other available/known solutions to the same/similar problems?

A) We have employed sensors previously used by others for waste extraction from drainages. Our approach, however, introduces a unique solution aimed at maintaining hygiene across open drainage systems and their surroundings. Our system features rotator mechanisms designed to lift waste efficiently. Additionally, we employ sensor-equipped machines connected to extendable rods, facilitating ground-level movement. These machines effectively clean up the surroundings, ensuring thorough waste removal. Unlike conventional methods that often float on drainage surfaces, our system operates from the road's edge, ensuring effective waste management without disrupting the drainage flow and it cleans both the open drainages and its surroundings simultaneously.

6. Please provide us with the advantages of your solution. Please Compare the advantages given the existing/conventional solutions uncovered during the search under point. You may make a table or figures. Further, you can provide us with the economic potential or commercial applications for the technology.

A)

Advantages:

- This machine can operate continuously without fatigue.
- It ensures thorough cleaning.
- Machines can work faster than manual methods.
- Reduces human contact.
- Improves hygiene and sanitation.
- And both machines can work together or individually also (Coordinated operations).
- Cost effective and reduces labour costs.

Feature	Existing Technologies	Proposed Technology
Cleaning Mechanism	Mechanical lifters, Conveyor belts, robotic cleaners. [1], [3], [5]	Tube-and-bucket mechanism with vacuum cleaner
Power Source	Batteries, solar power (in some systems). [3], [7]	Batteries
Hardware	Buckets, Sensors, DC motors, IoT boards. [1], [4], [6], [7]	Stepper motors, Sensors, IoT boards, tube, container
Waste Collection Method	Screens and buckets for floating debris. [2], [3], [5]	Container lifts waste into an inclined pipe for collection
Obstacle Detection	Manual observation, few robotic systems with sensors. [1], [3], [8]	Ultrasonic sensors for real-time obstacle detection
Monitoring and Control	Limited to basic controls, some systems may include basic sensors. [3], [4], [6]	Arduino-based control for stepper motors; real-time monitoring via sensors
Portability	Varies; some systems are portable, while others are fixed.[2], [6], [7]	Designed for easy mobility on land
Controlling	Often requires manual operation.[5], [8]	User-friendly interface with indicators for waste collection
Maintenance Alerts	Limited to manual checks. [7], [8]	Gives an alert when the trash bag is full.

Table: 2 Comparison

7. Please intimate if can think of any alternative way/solution of achieving the same result as your invention. Please note that the alternative way/solution that you are thinking of may or may not have the same advantages as offered by the invention.
A) No.

8. What are the novel aspects of your invention that need protection? Describe the technical difference between the conventional and available product/process and your solution.
A)
Simultaneous Cleaning Functionality: This innovation efficiently cleans the drainage and its surrounds at the same time, in contrast to conventional methods that usually only clean one. Operational efficiency is greatly increased by this dual functionality.

Vacuum Mechanism: This machine's usage of a vacuum makes it possible to efficiently collect solid waste from the vicinity of open drainage systems. Traditional cleaning techniques don't maximize trash collection since they frequently rely on physical labour or inefficient mechanical technologies.

Reduced Human Exposure: By minimizing direct human contact with dangerous substances during the cleaning procedure, the design lowers the possibility of coming into contact with dangerous chemicals and waterborne illnesses.

Modular and Adaptable Design: The machine is made up of semi-submerged parts and land-based parts that are joined by an extendable rod. Because of this versatility, components can operate alone or in tandem depending on the particular cleaning requirements.

9. Any environmental issues confronted while developing or implementing the invention?
A) No.

10. Please enlist all innovative features of your invention that you think are making the invention more sophisticated.

A)

1. We can concurrently clean the open drainage system's surrounds and drainage thanks to this idea.
2. It facilitates the effective use of time and energy by simplifying the cleaning procedure and lowering the need for heavy physical effort. During drainage maintenance, this also reduces the chance of human interaction with dangerous materials, which lowers the risk of exposure to dangerous chemicals and waterborne illnesses.
3. To ensure complete cleaning and avoid obstructions, the machine has a suction mechanism that efficiently gathers solid waste from the area around the open drainage system.
4. Flexible functioning is made possible by this machine's combination of land-based parts and a semi-submerged unit linked by an extended rod. These components can be used individually depending on the needs of the location or deployed combined for thorough cleaning.

11. What are the utilities/applications of the invention? Enlist them.

- This machine can be left on the roads which are margined with open drainages.
- This can be used in construction sites for constant cleaning.
- Can be used in residential areas.
- It is useful for collecting leaves and garbage like paper cups in the parks.

12. Has the invention already been implemented in any product or process?

A) No.

13. Has the invention been published or disclosed/discussed to anyone outside of your organization or any third party including abroad also (such as marketing meetings, conferences, tradeshows, trade fairs, websites, social media, newspapers etc.)?

A) No to the best of the inventor's knowledge.

14. Inventor details in the below format

Applicant:
School of Technology, Woxsen University

Inventors:
Mr. G. Kesava Datta
Dr. Bhanu Prakash S
Ms. V. Lakshmi Shivani
Ms. P. Kritika Reddy

References:

[1] Garingo, A. L. (2019). Automatic Drainage Cleaner using Atmega328P and Weight Sensor.

[2] Ramanathan, S., Sudharshan, R., Karthik, B., Suhail, A. M., & Chiranjeev, S. (2019). Sewage cleaning machine. *International Journal of Research and Analytical Reviews*, *6*(3), 124-129

[3] Sharma, A., Singh, A., & Singh, M. (2019). Automatic drainage cleaning system. *International Journal of Engineering Research and Technology*, *8*(05).

[4] Marcian, M. J., Sabarishwaran, S., Sudhagaran, D., & Sathiyapriya, S. (2018). Smart Drainage Monitoring and Clog Removal Using IoT. *International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET)*, *4*(4), 178-182.

[5] Sharmili, S., Saarika, T., & Malar, R. (2017). Intelligence drainage cleaning using an arm robot. *Int. J. Emerg. Technol. Comput. Sci. Electron.(IJETCSE)*, *24*(7), 63-66.

[6] Satpute S. S., Darole V. R., Khaderao P. M., Hiralkarl P. B. 2018. Automatic Sewage Cleaning System Int. J. Adv. Eng. Res. Dev. 5 434–9

[7] Swapnil A. K., Sanket W.T., Sachin P.W., Akshay V. S. Automatic Garbage Collector Machine International Journal for Scientific Research & Development| Vol. 6, Issue 01, 2018 (online): 2321-0613 6 1382–4.

[8] Varughese M D A 2018 Automatic Drainage Cleaning Robot Int. J. Res. Appl. Sci. Eng. Technol. 6 1087–90.