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Smart Drainage Cleaning System

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Abstract: In this project the proposal concept is to replace the manual work in drainage cleaning by automated system. We know that water has a great importance in human being life, the water flow in drain full of wastes like polythene, bottles, fabrics etc. The drains get blocked due to these wastes in water. Drainage are using for the disposal and unfortunately sometimes there may be loss of human life while cleaning the blockage in the drainages. The government also spends too much money to clean the drainages. This paper presents a mechanism for detecting and eliminating blockages in sewage pipes. This device is designed to replace human sewage cleaners in order to ensure their health and hygiene. The proposed device moves through the pipeline, detects the blockages if they are present and clears them by cutting through the blockage and moves forward. The operation is monitored and controlled manually by the sewage worker using a smart devices looking through the screen .The operator can monitor the insides of the pipe via a wireless camera attached to the robot[1]. The various sensors attached to the robot helps to determine the distance of the block from the robot and the presence of poisonous gases inside the pipeline. The rotating mechanism consists of a fan like structure with sharp blades that penetrate through the blocks by cutting them. This robot is used to inspect various pipeline elements of different size.
Key words: Sewage; pipeline; blockage; clearance; rotating.

1. Introduction

Every day hundreds of men descend into the putrid, foul smelling sewage for cleaning without any safety gear. Workers who handle the maintenance and cleaning of sewage pipes are at increased risk of serious diseases. Many deaths occur due to drowning, trench collapses, falls, and exposure to chlorine or Hydrogen- sulphide gas. Those who die during the duty are replaced by others, waiting to put their lives in danger just to earn a living for themselves and their families. Every week, men line up for Rs 200 that they get to clean around 20-25 gutters, putting their precious lives at risk. While sewage cleaning has become mechanized in some parts of the country, the government figures suggest nearly, 800000people still work as sewage cleaners [1].

In Metro cities, sewage travels across nearly 5,600 kilometres long sewer lines at the speed of one meter per second [2]. Reports suggest that nearly 23,000 men and women die in India every year doing various kinds of sanitation work. A research at Tata Institute of Social Sciences has found that 80% of the sewage cleaners die before age 60 because of work-related health problems. According to the Times of India, 39 out of 100 sewage men die every year.

According to an article in Times of India, on August 21ST,2017, a sewage worker dies while cleaning the block in the sewer [fig 1]. The survey says as it as a 10th death in a row with the period of 35 days. “Mechanised sewage cleaning is now an option but people still want manual scavengers to clean their drainages” says an article of India Times, published on October 4th 2018 [fig 2].

So, it is high time to replace human sewage cleaners with high tech robots in order avoid these unfortunate deaths and save their precious lives. This robot paves way for the sewage workers to monitor and clean the pipes without getting into the drainage [5]. This will not lead to unemployment instead it helps the workers to finish their job easily with the help of robot. This ensures the health and hygiene of the sewage workers.

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Fig.1: Sewage Man Cleaning Sewer In Delhi

Fig.2: Sewer Man Clearing the Block At Bangladesh

2] Pipeline monitoring

Pipeline is the major tool of transportation of oil, sewage, water etc. Many types of pipes are being used to construct important lifelines such as water and gas supply all over the world. Also pipes are widely used in chemical industries and in Gulf countries for carrying fuels like petrol, diesel, oil etc. But the disadvantage is that many problems like cracks, breakage and blocks are occurring in the pipelines because of natural calamities and mechanical damages from third parties which cause great loss. Thus scheduled proper inspection must be done on these pipelines for their maintenance. The manual cost of doing this inspection is very high and it requires lots of resource and time[3]. If robots inspect inside the pipes, fast and accurate examination at low cost is possible.

Pipeline Assessment Devices called pigs are available which use ultrasonic technology to determine pipeline wall cracks. Pigging operations include inspecting and cleaning the pipelines. This is accomplished by inserting the pig into a "pig launcher"-an oversized section in the pipeline, reducing to the normal diameter. The launching station is then closed and the pressure-driven flow of the product in the pipeline is used to push the pig along down the pipe until it reaches the receiving trap - the "pig catcher" or "receiving station" [fig.3].

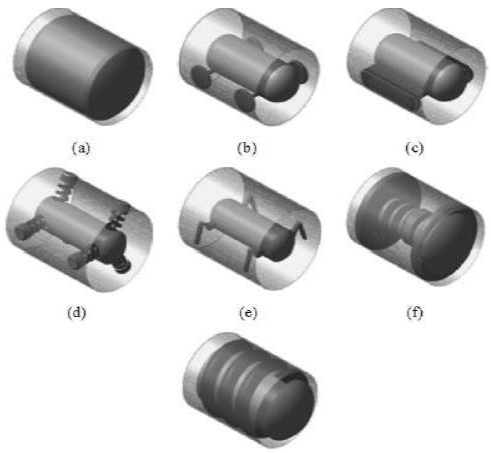

Fig.3: Classification Of In Pipe Robots (A) Pig Type (B) Wheel Type (C) Caterpillar Type (D) Wall Press Type (E) Walking Type (F) Inchworm Type (G) Screw Type[1]

The same algorithm can be used to inspect the sewage pipes but clearing blockages in the pipeline will not be possible by this method. This is because the flow of pig will be interrupted by the different types of blockages present in the pipe. The blockages might include plastic waste, mud, stones, waste

clothes etc. In order to determine the type of blockage, wireless cameras are attached to the robot Ultrasonic sensor can be used to determine the distance of the block from the robot. The wireless camera helps the operator to monitor the pipeline continuously..

3] Determination of the position of block inside the pipe

The robot moves through the pipe by balancing on its wheels. Ultrasonic sensor HCSR04 [fig 2] is assembled in the robot. Ultrasonic sensors are non-intrusive in that they do not require physical contact with their target. Ultrasonic sensors are based on the measurement of the properties of acoustic waves with frequencies above the human audible range, often at roughly 40 kHz. They typically operate by generating a high-frequency pulse of sound and then receiving and evaluating the properties of the echo pulse [5].

Three different properties of the received echo pulse may be evaluated, for different sensing purposes. They are:

- Time of flight (for sensing distance)
- Doppler shift (for sensing velocity)
- Amplitude attenuation (for sensing distance)

i] Distance sensing (Time of Flight)

a) Reflection Mode

In reflection mode (also known as "echo ranging"), an ultrasonic transmitter emits a short burst of sound in a particular direction [fig 4]. The pulse bounces off a target and returns to the receiver after a time interval **t**. The receiver records the length of this time interval and calculates the distance travelled **r** based on the speed of sound **c**:

r = c * t

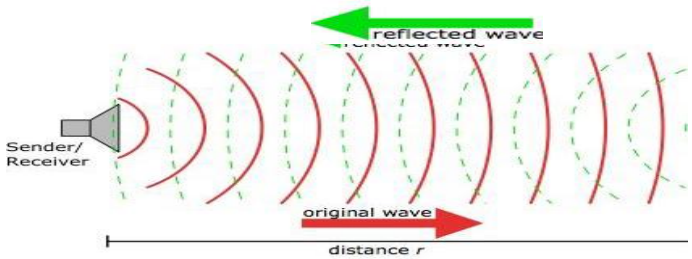

Fig.4: Reflection Mode

Very often, separate transmitting and receiving transducers are placed immediately next to each other, housed as a single unit. In these cases, the distance calculated will be twice the distance from the sensor to the target.

a) Direct Measurement Mode

In this mode of operation the transmitter and receiver are two separate units that move relative to each other. For example, the receiver can be fixed to a target that moves relative to a stationary transmitter, or vice-versa.

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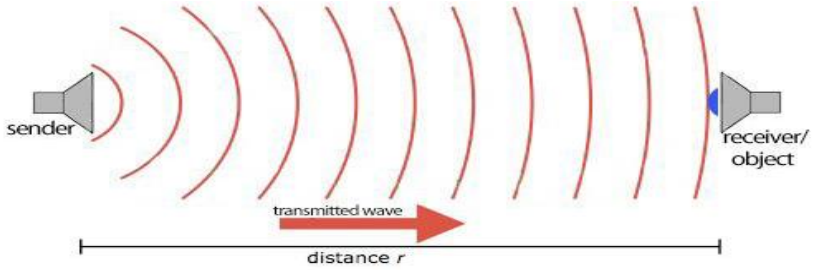

Fig.4a: Direct Measurement Mode

Multiple transmitters can be used to increase the directionality of the transmitted pulse, whose signals were received by multiple receivers in the performance space, enabling a computer program to triangulate the performer's position [fig 4a].

ii] Sensing Velocity (Doppler Shift)

When a wave reflects off of a moving object, its frequency is shifted by an amount proportional to the velocity of the object. This fact can be exploited in ultrasonic sensing by having the receiver measure not the time of flight but the frequency of the returning echo pulse. Knowing **fe** and **fr**, the frequency of the emitted and received pulse, respectively, the velocity **v** of the target may be calculated.
fe - fr = 2 fe (v / c) cos(A)
Here, **A** is the angle between the target's and the pulse's lines of motion.

iii] Amplitude Attenuation (Distance sensing)

Ultrasonic sound attenuates much faster than audible sound when propagating through air. By measuring the intensity of the returning pulse, an estimate of the distance travelled can be made using the following equation:
I = I0e-ax
Where **I** and **I0** are the received and the original intensities, respectively, and where **a** is the attenuation coefficient (a property of the medium) and **x** is the distance travelled by the wave.

4] Blockage Clearance Mechanism

Once a block is identified and its distance is measured using the ultrasonic sensor, the next step is to clear the block using the mechanism which comprises of a high pressurised blades. High pressurised blades have been developed with the aim of removing stubborn dirt under tough working conditions [fig 5]. The device is even provided with a pumping water mechanism in case to flush the dirt in the sewer lines. Efficient flow rates are achieved using high flow rate and high pressure.
Water gets things so clean because its molecules have a slight electrical polarity (one end is positively charged and the other is negatively charged). Detergents (soap chemicals) help water to do its job even better by breaking down gunges and grease and making it easier for water to flush away. But some kinds of ground-on dirt just won't budge, no matter how hard we try. That's when a pressure washer is used. It uses a narrow, high-pressure jet of hot or cold water to blast dirt free. Because the water is travelling fast, it hits the dirty surface with high kinetic energy, knocking dirt and dust away like a constant rain of tiny hammer blows. It's only water, though, so it doesn't damage most hard surfaces.
Once the block is cleared using the high pressure pump, it is indicated to the robot by using the ultrasonic sensor distance measurement and the robot proceeds to clear the next blockage along the length of the pipe.

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Fig.5: Drainage Cleaner

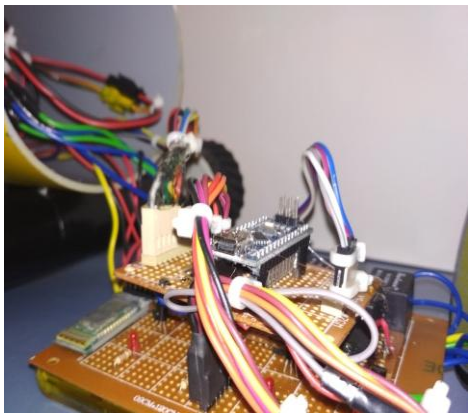
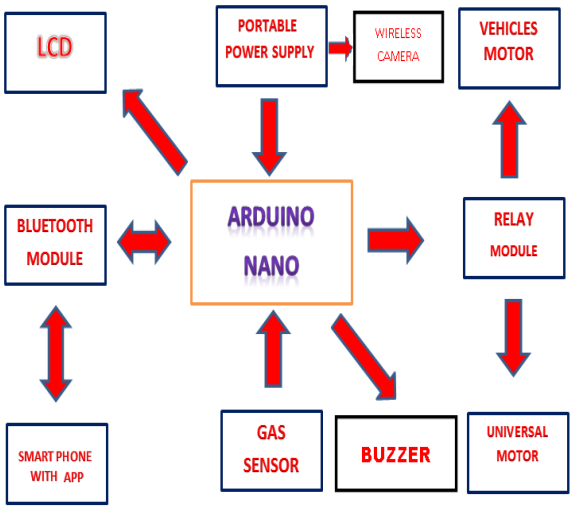


Fig.6: Microcontroller Board

5. Block Diagram



6] Control Operation

All the activities of the device are controlled by a centralized microcontroller attached with the machine. This controller is interfaced with the wheel motors, wireless camera, gas sensor, driver circuit. Micro controller does the following function:

1. When the operator turns on the device, the microcontroller enables the driver circuit [fig 6].
2. The driver circuit enables the motion of the device inside the pipeline by turning on the motors. The operator can control the movement of robot as per pre-programmed instructions.

3. The wireless camera continuously transmits the information to the controller which shows it in the user's display device.
4. When the controller senses an abrupt blockage through ultrasonic, it confirms the presence of a blockage. The controller now interrupts the driver circuit and turns on the blade motors.
5. The mechanism is operated till the blockage is cleared. Once the block is cleared, the controllerreturns back the control to driver circuit for the forward motion of device.
6. A rotating mechanism is used for stubborn blockages such as wood pieces, thick sheets etc,. It consists of a rotating fan like structure with very sharp blades. This is capable of cutting the wood

pieces, covers, boxes etc. Thus, the device penetrates into the block by cutting down it into pieces. Later, pumping mechanism can be used to clear or flush out the remains of the debris of the block.
7. The display device is interfaced with the controller and it helps continuous monitoring by the user.
8. The gas sensor is turned on only in a rare case if both pumping mechanism and rotating mechanism are unable to remove the block. In such a case, the output of the gas sensor is used to determine whether poisonous gases such as chlorine or carbon monoxide are present inside the pipeline. This provides precautionary measures for the sewage workers before getting into the drain.

7] Conclusion

The proposed machine is designed with the motive of helping the sewage cleaners to prevent them from getting affected by serious diseases because of entering into the drainage. The death rate of sewage cleaners is alarming. It is high time that this machine should be implemented to clean the sewage pipes all over the world. Moreover, this device will help to find the poisonous gases inside the drain which will help the authorities to curb the dumping of untreated raw waste from the industries into the drains. This will not lead to unemployment of sewage workers but will just make the job easier and healthier for them. When this device would be implemented in real time, it will save thousands of poor people's lives who come forward to clean the drainage just to earn few bucks a day. In this modern society, a human cleaning the sewage waste shows that very less attention has been given to those people's lives due to their poverty. Hence, this robot helps to have a clean and hygienic drain systems everywhere.

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