BHRTYARTANA
(A PIPE CLEANING AND INSPECTION ROBOT)

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Abstract

Manual scavenging was ruled illegal in 2013, but private contractors hired by the municipal government continue to employ manual scavengers. Hundreds reportedly die from the work each year. To provide a complete solution to this deplorable situation, artificial intelligence is used as a replacement to manpower. The sewage inspection and cleaning is done by a mechanical device driven by electronic automation. BhrtyArtana (where 'Bhrtya' means robot and 'Artana' means waste) is an automated sewer robot that can conduct an inspection of the sewage pipeline and clear any blockage within it. The robot first inspects sewer lines for cracks, corrosion, obstacles, etc. A camera installed atop the robot carries out live streaming of the interior of the pipeline. These visuals are viewed by the operator in software to be recorded for future reference. Furthermore, the robot is equipped with a proximity sensor at the front of its body to detect the presence of an obstacle in front of it. As the robot nears the obstacle, the turbine starts cutting through the obstacle, thus, clearing the obstacle. Thus, this device effectively decreases all the predicaments associated with sewage cleaning and inspection.

Index Terms: inspection robot, obstacle clearance, pipe cleaning robot, sewer robot.

I. INTRODUCTION

The Sewage is a harsh environment which demands periodical inspection and clearance due to various issues like entrance of roots, corrosion of pipe material, etc. Due to these damages, the groundwater is increasingly contaminated. Furthermore, heavy rainfall events may lead to inroad of the systems, resulting in overflow. Sewage may leak out polluting soil and ground water or it may wash away soil, crowding the pavements. Sewage contains chemicals, most of which are not biodegradable causing the emission of fumes toxic to humans and animals.

Internal inspection and maintenance has so far only been possible where pipe diameters are large. Relatively small sewers do not offer enough space for human beings, and whenever they were damaged the only solution was to expose the affected pipe sections.

Thousands of sewer cleaners are risking their lives every month in the Indian business hub of Mumbai because of a lack of basic safety gear. The workers, who are mostly from low-caste communities, die before age 60 because of work-related health problems. In Mumbai, an average of 20 sewer workers die each month from accidents, suffocation or exposure to toxic gases, the study found that they have to deal with filthy conditions and dangerous gases.

Workers use metal scrapers, brooms or their bare hands to clear drainage and sanitation lines. They are often surrounded by swarms of cockroaches and no mask to protect them from the poisonous fumes that the sewage emits. Sometimes, they need to go much deeper underground with only a rope for help and can drown if they get caught in a sudden rush of sewage. While theirs will always be a difficult job, it does not need to be such a risky one.

So due to the existence of small diameter pipes, unsuitable environment in sewer pipes and additionally, the necessity to inspect live networks demand the application of a robot for this assignment.

Nowadays, sewer robots with state of the art camera electronics and drive components reduce the cost of inspection, maintenance, and repairs to underground sewer networks. Optimally configured, extremely small drive solutions are the key component to enable flexible activities even in narrow pipes. The reliability of miniature DC motors and their high level of efficiency permit extremely compact designs.

II. MECHANICAL DESIGN

A. Body

The body of the robot must be small in size but long enough to accommodate all of its components like sensors, circuits and its power supply. The robot in this paper is designed for pipes having an inner diameter of 10inches. Thus, its body has been designed using a PVC pipe of inner diameter 8inches. Using a material like PVC has added to the lightness of the entire robot body enabling it to be carried easily.

The remaining parts of the body are attached on to the top and sides of the PVC pipe.

B. Traversing Mechanism

There are different types of traversing mechanisms that can be implemented for an in-pipe inspection robot. The choice of the traversing mechanism can be complex due to the environment in which it must be implemented. In a sewer network, the terrain houses many obstacles but they are not taller than 10% of pipe's diameter after clearing them. Thus, a wheel wall pressing type mechanism has been chosen and implemented.

With 2 wheels attached on each side of the PVC pipe, as shown in FIG.1, the robot moves with 4 wheels in total touching the ground to provide increased traction and stability. Each wheel is attached to the body by aluminum clamps and suitable screws hold them in place.

C. Camera Head

An important function of a sewer robot is to facilitate in-pipe inspection. This goal is achieved by the use of a camera. A wireless camera is enforced to obtain visuals of the interior of the pipe which is under inspection. The wireless camera is attached to the top of the pipe at the front to obtain a complete view of the pipe. Live images are transmitted by the camera to a user front like a PC which is received by an RF receiver.

D. Propeller System

A main function of this robot is to perform obstacle clearance. A propeller can be installed to facilitate this function. A shaft that runs along the axis of the robot must be held in place using a nylon rod. The nylon rod is turned suitably to act as a stopper at the front of the robot. This protects the electrical devices embedded in the robot body against the water that might enter the body when the robot is placed inside the pipeline. Ball bearings assist the shaft in smooth rotation.

The propeller is powered by a high voltage battery which runs a motor attached to the shaft. The motor is held in place by clamps and screws.

FIG. 1 Design of the robot wheels

III. ELECTRICAL DESIGN

The electrical deign and components of the designed robot have been presented below.

A. Design

The robot is neither controlled remotely nor does it obtain power supply through cables. FIG.2 illustrates a block diagram of the hardware of the robot.

The block diagram is basically of 2 parts: the robot part and the user front. The electrical devices are placed inside or on the robot which is categorized as the robot part.

B. Electrical Parts Details

Electrical actuators are easier to control, derive and utilize among the industrial actuators and are the most suitable for a sewer robot. Among electrical actuators, DC gear motors are chosen.

High quality images are transmitted by the wireless camera through its antenna to a receiver powered by a DC cable. The interior of a pipeline is dark and requires proper lighting for visibility. An IR camera helps in minimizing a component that provides lighting thus adding to the lightness of the robot part.

In this paper, the robot includes a proximity sensor to sense the presence of an obstacle. Among the proximity sensors, an IR proximity sensor module is chosen.

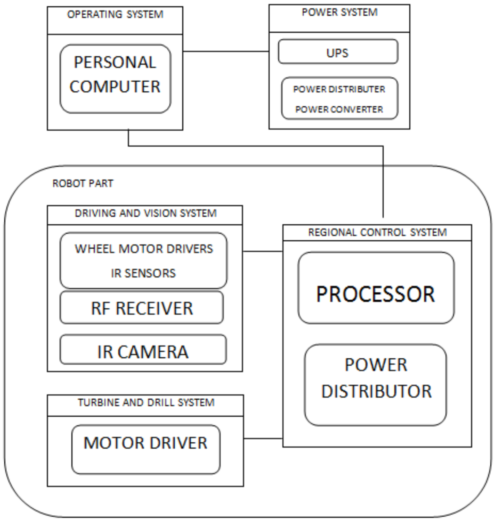

FIG. 2 Block Diagram of the Hardware

IV. SOFTWARE

The operator views the entire process of the robot through the images sent by the camera to the PC at the user front. The images are seen on a software installed on the PC at the user front. Since a main function of the robot is yielding images from the inside of the pipe, a good view of the pipe is presented at the user front. The camera performs live streaming of the interior of the pipeline during the mission of the robot. The visuals can be recorded as a video file. FIG.3 shows an image captured by the robot inside the pipeline.

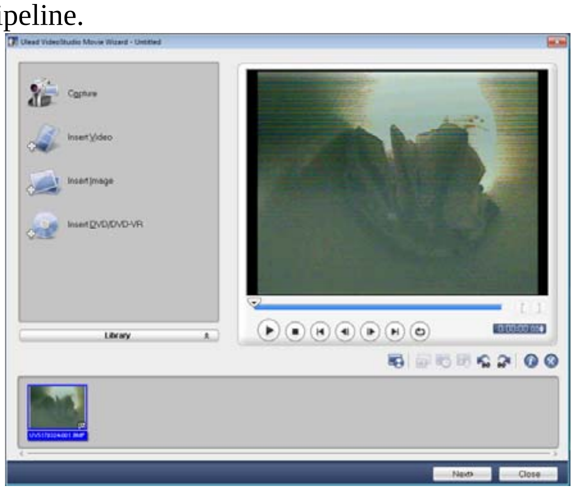

FIG. 3 Image captured by the robot

V. CONCLUSION

This paper proposes an innovative, fully autonomous and un-tethered sewer inspection and clearance robot which fits into pipes having an inner diameter of 10inches. Inspection is carried out by live streaming of the interior of the pipeline. Since the visual obtained can be recorded in the software, the data can be utilized for study of sewer pipelines.

In conclusion, the objectives of the review paper were met where the robotics application in in-pipe inspection was understood, reviewed and discussed. The same project can be extended by installing springs on the legs of the robot to adapt to different pipe diameter. Further research can be done to detect the navigational landmarks such as manholes and pipe joints independently.

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