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ABSTRACT – Inspecting inner walls of a pipeline is very challenging and difficult. There can always be some internal walls, which are having some cracks, and there can be any obstacles which can block the passage and affect the flow. Thus, we propose a Multi Gait Snake Robot For Inspecting Inner Walls Of A Horizontal Pipeline to overcome this problem. So, here our research provides solution by fabricating a snake robot that is capable of moving through the inner walls of a horizontal pipeline. With this technology our project addresses the majority of the challenges and issues experienced while carrying out pipeline operations. Practical impossibilities concerning the design of an in-pipe inspection robot (IPIR) include Mobility, Turning radius, Size and shape adaptation, Flexibility, Stability, Autonomy and obstacle avoidance, control. Therefore, a way to solve this is to design a snake like robot with dimensions similar to a real snake. This robot is capable of entering small diameter pipelines and can detect any cracks or any obstacles present inside the pipeline.

KEYWORDS – Camera, Pipeline, Blockage, Snake Robot, Cracks, Pipeline Inspection

INTRODUCTION

Robots designed for inspecting pipelines have gained prominence in several industries. It is a fact that snakes are quite elastic and have a great range of motion. They can practically ambulate in any kind of terrain or environment [1-14]. Likewise, since the introduction of these pipes, which are used chiefly to transfer water, sewage, liquid gas, and oil, impossible for any other material to perform this particular function, there have been a lot of developments. However, some factors, such as fracture, clogging, and others, cannot be prevented by Pipelines [15]. A sophisticated robotic system that incorporates a multi-gate snake robot built for the purpose of inspecting pipes is capable of navigating similar to a snake within the inner walls of a pipe [22]. With the objective of crossing through pipes, these robots are inspired by snakes and their elegant locomotion, going a step further and hoping to gather inspection data as well as carry out maintenance activities, without great physical input and the disruptive action of digging up the ground [23-26]. A Snake robot is characterized by an arrangement of a number of segments connected in such a way that they can move with respect to each other that enables the robot to execute some gaits like: slithering, sidewinding, coiling and so on [27]. Such flexibility comes in handy for multi-gait snake robots in the performance of functions such as search and rescue, surveillance and environmental monitoring where they are able to fit into and move along constricted and rough terrains quite comfortably [28]. In the case of snake robots, as one studies the different curves or shapes in turn, one observes that each shape produces different crawling effects. A wheel-less operation of the snake robot is what we focus on in this case [29]. Pipe inspection is a difficult process and only experienced professionals can carry it out. There are few existing inspection techniques currently but they are not precise [30].

EXISTING PIPELINE INSPECTION METHODS

- Ultrasonic Testing
- Hydrostatic Testing
- Visual Inspection
- Leak Testing
- Pneumatic Testing
- Radiographic Testing

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EXISTING METHOD CHALLENGES

1. Challenges are faced while inspecting pipeline integrity such as cracks and blockages.

2. During inspecting pipelines with varying diameters and sharp bends.

3. Flexibility of the product/device used for the pipeline inspection that can access through complex pipeline works.

LITERATURE SURVEY

Jingwei Liu et. al., discusses how the snake robot can demonstrate the inspection for simple traveling wave movement is sufficient for small diameter pipes inner wall inspection, yet highly sensitive visual inspection of the inner wall of large diameter pipes demands it to move through a helical gait that closely hugs the inner wall. [1]

Sabir Kazeminasab, et. al, developed a snake robot pipelines are the basic medium of gas and liquid transport. It transports oil, gasoline, water, or sewage. These are checked and maintained on a regular basis to prevent cost overrun and to run smoothly. [2]

Shogo Satomura, et. al developed a new type of snake-like robot by connecting screw- drive units through active joints.[3]

Akina Kuwada, et.al. The principle of "sinusoidal wave drive" is applied to develop the robot such that robots can negotiate curved pipes and pipes of different diameters independently. [4]

Amr Bekhit, et. al, developed a robot is capable of operating on active pipeline, then it would certainly have huge industrial and commercial value. Designing an inchworm robot with the Gough-Stewart parallel platform for presentation. [5]

Mohd Zamzuri Ab Rashid, et, al. derived in-pipe inspection robotic system, an emerging alternative to conventional x-ray inspection, visual inspection, as well as other NDT equipment that will move inside the pipeline to conduct a pipe integrity assessment. [6]

Anojan Selvarajan, et. al, developed When it comes to pipeline inspection, snake robots can easily access wide pipeline range which consists of pipeline in the oil industry of a large diameter to pipers that can be called the sewers of very small diameters.[7]

Jalal Taheri et. al, gave an overview of in-pipe robots on geometric structures, propulsion mechanisms, Kinematics designs and steering mechanisms. [8]

Kamilo Melo, et. al, modular snake robots traversing across horizontal pipes of different sizes were tested on different gaits. A visualization tool was used in order to verify the gait designs before implementing them on the real robot.[9]

Frantisek Trebuna, et. al, the snake robot for pipe inspection, by show case development of its mechanical, electrical design as well as analysis of the robots locomotion. [10]

Tatsuya Takemori, et. al, developed project outlines the approach to design snake robot gait in purpose of expressing a desired snake robot shape as a series of pre-defined curves with specified curvature and torsion. [11]

Aniket Nagesh Colvalkar, et. al, noted that in the construction of such underwater vehicles pipework of different shapes and operation conditions of slotted plungers (joints, couplings, T-sections) and manufactured with the necessary frictional force during vertical movement have been used. [12]

Tianyu Zhou, et. al, developed snake robot’s teleoperation control as there are workplace constraints including but not limited to unique locomotion mechanism and low visibility. [13]

David Rollinson, et. al, developed a co-axial method of whole - body control of a snake robot has been proposed, which enables an external control of the robot’s morphing into different shapes in the environment. [14]

Ankit Nayak, et. al, developed this In-pipe inspection robot is a wheeled fixable lead screw type wall pressing in-pipe inspection robot model on wheels. [15]

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Fumitoshi Matsuno, et. al, developed Tough Snake Robot Systems Group: nonwheeled-type snake robot, and a wheeled one, where active wheels are integrated. The other applications explored include investigation of out and inside of pipes, rubble, and even exploring ridge-pole ladders.[16]

Nana ZHU, Inspired from the S winding movement of snakes in nature, by analyzing actual snakes' movement principle, a kind of bionic snake robot with single motor is designed. [17]

Alireza Javanbakht, et al., made snake robot from spherical modules. For climbing purposes it is crucial how tight the robot is against the pipe walls. [18]

Mariko Inazawa, et, al., This is apparent from the rage of pipe shapes and sizes that render this system unable to adjust. Developed a system whereby a single robot is capable of working with various pipe structures to overcome such challenges. [19]

Kesteloo, T.V., et. al, Constructed a pirate robot, capable of maneuvering through complicated piping systems, now includes a progressive control layer that increases its autonomy.[20]

Rajendra B. Mohite, et. al, designed a robotic mechanism to inspect pipelines in industries that have an extensive network of pipelines. Manually looking for defects in such pipes is not only laborious but almost unachievable. [21]

B.V.L. Deepak, et, al. undertook in-pipes inspection operation to explain the processes of identifying defects cracks corrosion cuts blockage and covered paint thickness. [22]

Haruki Tanihira, et.al, created a snake type robot which has a broad brush to clean all the wall surfaces inside the pipe and rotational movement of the robot. [23]

Zichao Ji, et al., propose a robot with a gripper that is fitted with a camera and laser range finder allowing it to observe the environment and pick up objects.[24]

Sheraz Yaqub, et. al, focuses on building Modular snake robot its 3-D movements have been analyzed by researchers for pipe inspection and stairs climbing etc. The angles between their joints are determined with the help of Bellow's model, which is based on curvature and torsion of the backbone curve. [25]

Swaminath Venkateswaran, et, al, there is a strong rationale for the development of piping inspection robots in industries such as nuclear, chemical and sewage. [26]

Ivan Virgala, et al., developed a snake robot which moves in a pipe using a traveling wave-like a trapezium. A studied model of motion of the snake robot while in a pipeline of square cross section was presented. [27]

Nur Shahida Roslin, et. al, incorporated hybrid locomotion in their studies as a means of attaching two or more propulsion mechanism in order to realize a robust but yet flexible robot platform. [28]

M Z A Rashid, et. al, designed a snake robot focusing on the designs, locomotion of the systems and the actuator that will actuate or provide force to drive the in-pipe robot forward. [29]

Xuesu Xiao, et. al, proved the capabilities of snake robots in for extreme spaces, such as in a collapsed building where the snake either engages in active locomotion in spaces with over narrow pipes or tunnels or axial thrusting motion through a coarse medium composed of dirt and rubble. [30]

PROPOSED SYSTEM

In order to address the challenges mentioned, we present 'A Multi-Gait Snake Robot for Inspection of the Inner Walls of Horizontal Pipelines'. Snake robots are a special kind of apparatus used for travel inside pipes. Traveling inside pipes can be quite difficult considering that the pipe may have an intricate and a winding network of passageways. Hence, here

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we are building a snake robot that can traverse intricate and winding networks. Such robots are commonly used to protect the structural integrity of the pipes and to locate such problems as corrosion, plugging, or other damages of the pipe structure. For this case, our robot is composed of several segments or modules. There are adjustable segments. Internal body inspection is done using high-grade cameras and sensors in them. Our robot has a camera as well which is used to project light into the pipe. This is how the robot that is being designed will function.

CHALLENGES IN OUR RESEARCH

1.Pipe Conditions: The robot should be able to handle various pipeline conditions such as diameters, bends and structures. This is a huge challenge.

2.Durability: The robot should be properly fabricated in such a way that it should withstand harsh conditions inside the pipeline.

3.Maintenance: The robot should be properly maintained to ensure its reliability and condition of the various components.

4.Signal Transmission: There is a huge challenge in transmitting data and control signal through the pipeline.

5.Data Interpretation: The collected data analyzed by the robot requires skilled operators and advanced algorithm to identify the issues or defects present inside the pipeline.

These all are the basic challenges faced in our research.

TYPES OF PIPELINE INSPECTION ROBOT

1.Inchworm robots

2.Crawler Robots

3.Pipeline Inspection Gauges

4.Magnetic Robots

5.Spherical Or Rolling Robots

COMPONENTS USED

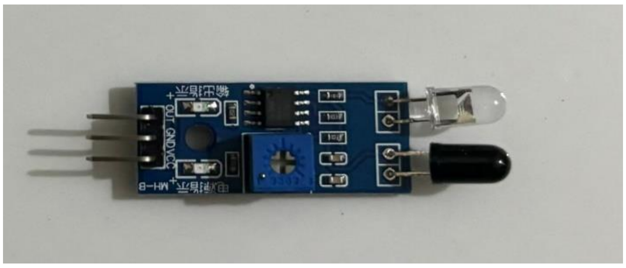

Fig:1 Infrared Sensor

Fig:2 Camera

Fig:3 DC Motor

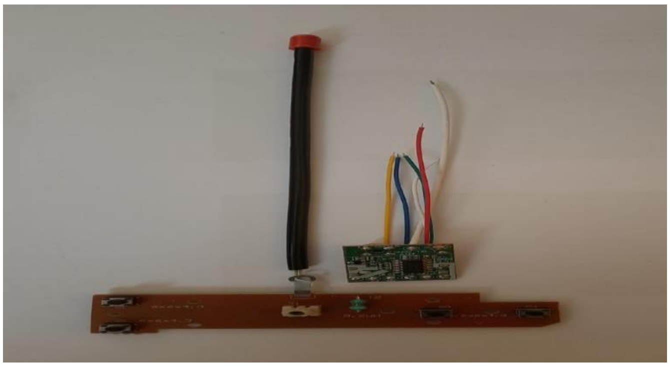

Fig:4 4 CH RC Controller

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Fig:5 Lithium Ion Battery

Fig:6 LED

Additionally Cameras, Wheels For Movement, Connecting Wires are used. The body of the robot is 3D printed.

WORKING

STEP 1: Snake robot is powered on.

STEP 2: Sensors and actuators are activated.

STEP 3: Sensors detect the environment.

STEP 4: Data is transmitted to the control system.

STEP 5: Each module receives control signals from the control system.

STEP 6: Sensors continuously monitors the environment.

STEP 7: Control system used the sensor data to identify the issues.

STEP 8: Blockages and cracks are identified and the report is generated.

CONCLUSION

Thus the development of snake robot significantly helps in inspecting pipelines which is having complex shapes and curves paths. Our project will help to overcome the challenges faced by existing pipeline inspecting methods and can ease the complication which is faced during pipeline inspection.

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