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DEVELOPMENT OF ROBOT FOR INSPECTION OF PIPELINE FROM INSIDE

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Abstract: Worldwide pipelines are widely used to transportation of fluid. The fluids transported through the pipeline commonly are hazardous to human or environment. If such fluid or gasses are leak through the pipeline then accident may occur. Leak detection in transmission pipelines is very essential for safe operation. It may lead to loss of human life and property in fire hazards due to delay in detecting the leak in pipeline. In such scenarios pipeline monitoring systems plays an important role to avoid such loss. Pipeline monitoring system detects the leakage of pipeline and location of that leakage. This paper provides overview of the system which provide internal leak detection of pipeline with help of robot, that robot is to be travelled through the pipeline. Sensors mounted on the robot detect the leak and send its location to the authorized person.

Keywords — pipeline, transportation, detect, safe, operation, hazard, robot.

I. INTRODUCTION:

The large pipeline structure is used to transport fluids and gasses from one place to other in the large industries, water distribution systems in large cities. However, these pipelines will gradually wear out through years of usage and may develop leaks over time. Such leak may loss the large amount of fluid which is transported through the pipeline. It will increase the maintenance cost. There are chances of accidents to occur due to leak in pipeline. It leads to loss of property and may loss the human life.

To avoid such losses, we proposed a system which can detect the leak and corrosive part of the pipeline and send the location of the leak and corrosive part of the pipeline. This system has robot which will travel through the inner part of pipeline. There are some sensors installed on the robot along with camera which will monitor the inner side of pipeline and send the images of inner part to the computer and then computer will detect the leak with help of image processing algorithms. If it detects the leak then it will locate the leak. This will help reduce the accidents and it will also reduce the maintenance cost.

II. IMPLEMENTATION:

The proposed system has most favourable performance and extra characteristics are introduced as compared to the present systems. Here, the objective is to determine the precise location of cracks present in pipelines. The proposed system can be divided into two parts first is development of robot and second is implementation of Image processing algorithm.

The first part developing such a robot which can be inserted into pipeline to travel through it and sensors are mounted on the robot which will be taking the information and images from inside part of pipeline. The robot will send this information to the master computer through Wi-Fi connectivity. The robot movement can be controlled through the master computer. The second part is implementation of Image Processing algorithms which will compare the images and then find out the corrosive part or leak from the pipeline.

- **Controlling of the robot:** The robot is controlled using the Forward/Start, Backward, Left, Right commands. These commands are sent from dashboard which is on the computer. The fig. 3 shows

the dashboard used for this system. The commands transmitted through Wi-Fi to the ESP32 which is mounted on the robot. ESP32 will transmit these commands to microcontroller through UART communication.

- **Image capturing:** We are capturing images from inside of pipeline. An image is captured using the camera, which is connected with ESP32. The captured image will be taken for processing as an input image.
- **Image Processing:** It is a technique or a method which perform some operations on an image, in order to extract some useful information from it or to get an enhanced image. It is a kind of signal processing in this processing input is an image and output may be image or feature associated with that image or some characteristics
- **Binary Image and Masking:** The captured image is converted to the Binary image using MATLAB inbuilt functions. It replaces all pixels in the input image with luminance higher than level with the value 1 (white) and replacing all other pixels with the value 0 (black). In masking an image is a processing of image where the all the pixel values are zero are replaced with the background image.
- **Corrosion Detection:** Edge detection algorithm is applied on result image. If the area of the edge detected image is more than the threshold value, then it will finalize it as corrosive pipe.

III. BLOCK DIAGRAM:

The figure (Fig. 1) shows the proposed system's block diagram. This system is implemented with microcontroller, sensors and Wi-Fi. The system is implemented with help of one robot on which ultrasonic sensor, gas sensor and wireless camera are mounted. The robot is inserted in the pipeline and the sensors on the robot are collects the information of pipeline and sends it to external computer for processing.

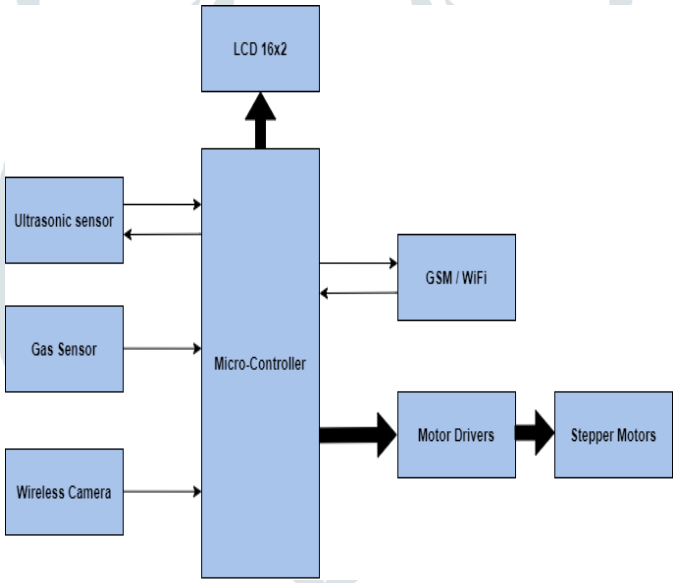

Fig 1: Block Diagram of system

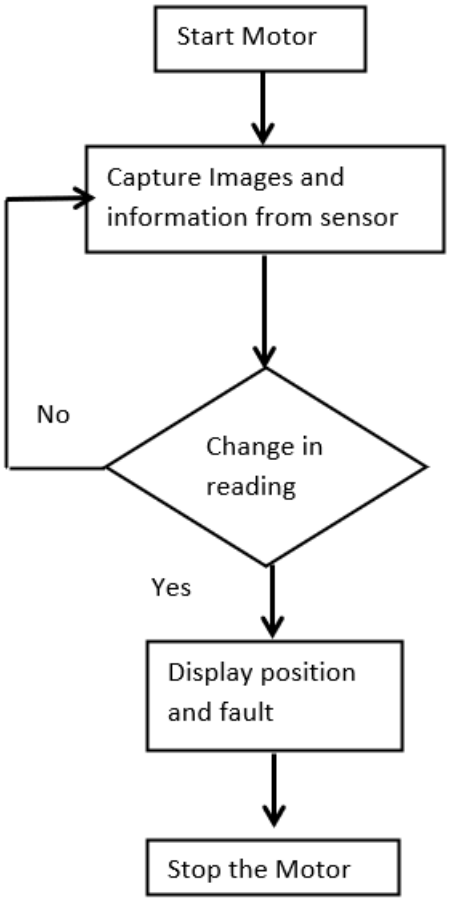

Fig 2: Flowchart of system

The figure (Fig. 2) shows the flowchart of the system. First, we have to power on the system and insert the robot inside the pipeline. Sensors and Wireless camera are mounted on the robot. Wireless camera capture images of inside wall of pipeline. These images then send for further processing to master computer. In processing using MATLAB software edge detection and color detection algorithms are implemented on image. If there is any finding from the algorithms, we will display that finding and position of that that finding on the display. The position is calculated based on the distance traveled by the robot, that distance can be calculated by steps traveled by stepper motor of robot. The ultrasonic sensor is used to detect the obstacles in the path and distance from the robot. If is there any obstacle then it will show a warning and further necessary action can be taken by the maintenance team. The robot's movement or speed is controlled by the master computer by sending commands via Wi-Fi connectivity. All the sensor data is received at master computer via same Wi-Fi connection.

IV. RESULT AND DISCUSSION:

This section illustrates that the result of the proposed system with respect to existing methods in terms of specificity, sensitivity and accuracy.

The experimental setup of the proposed system is implemented in MATLAB operating in the computer containing windows 10 OS and 2GB RAM. To implement the system, we prepared one pipe like structure and created one corrosive region with help of white blank papers and the robot is inserted to travel inside the pipe. The figure (Fig. 3) shows the robot.

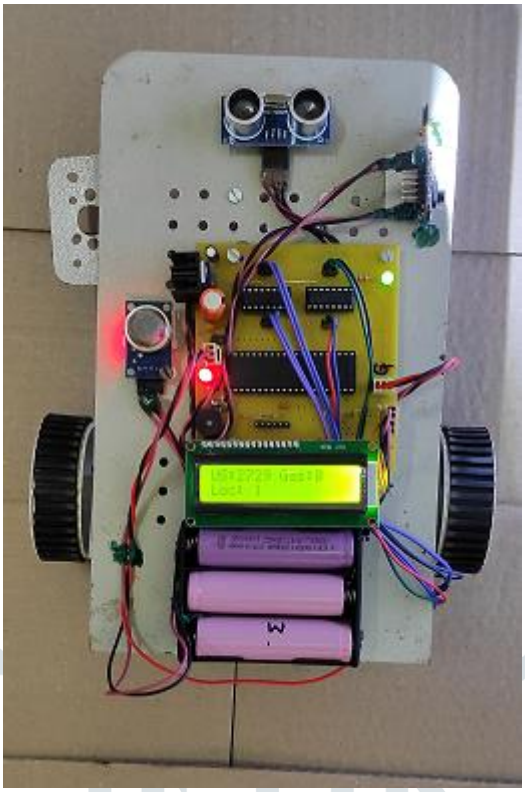

Fig. 3: Pipeline Inspecting Robot

The figure (Fig. a) shows the captured image of pipe from inside, in which the corrosive part can be seen. This image is then converted to binary image on that image we are applying edge detection and color detection algorithm. The figure (Fig. b) shows the binary converted image. And figure (Fig. c) shows the edge detected and color detected regions of that image.

The dashboard of the application shows captured images and the other parameters from the sensors and the exact location from the motors.

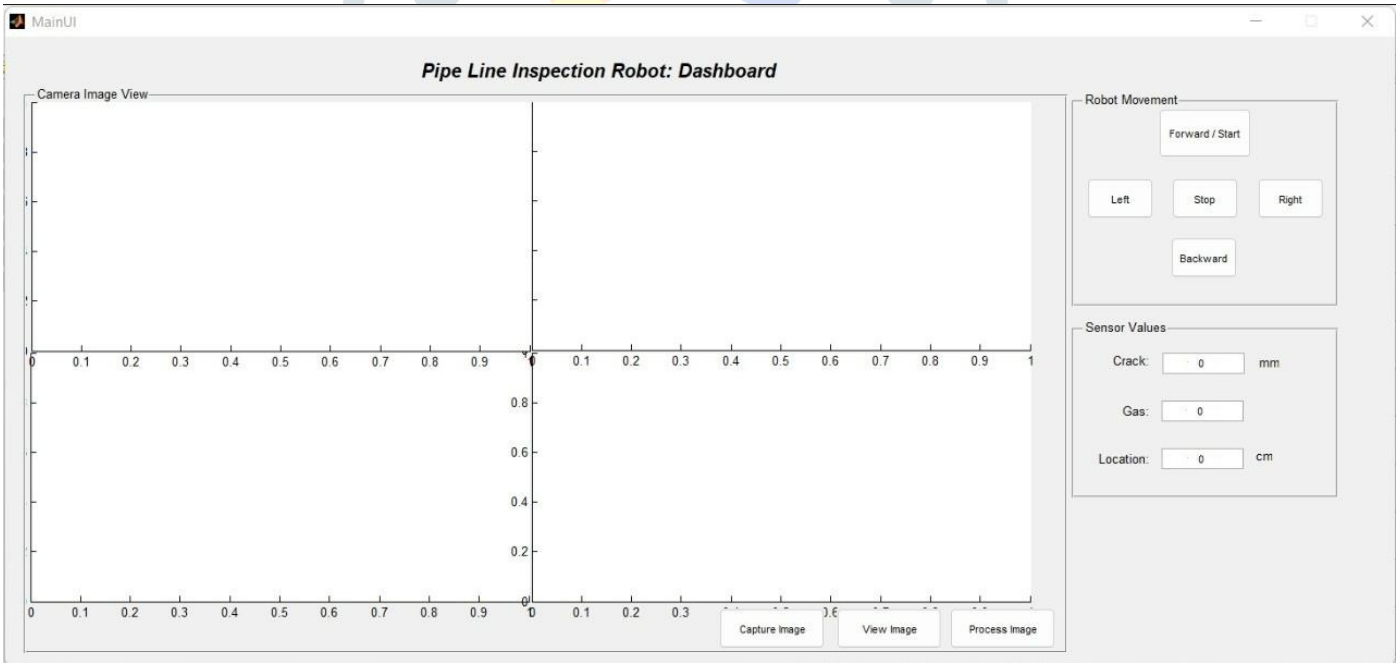

Fig. 4: Dashboard

The figure (Fig. 4) shows the dashboard on which we can see all the results provided by the system and the robot can be controlled from this dashboard.

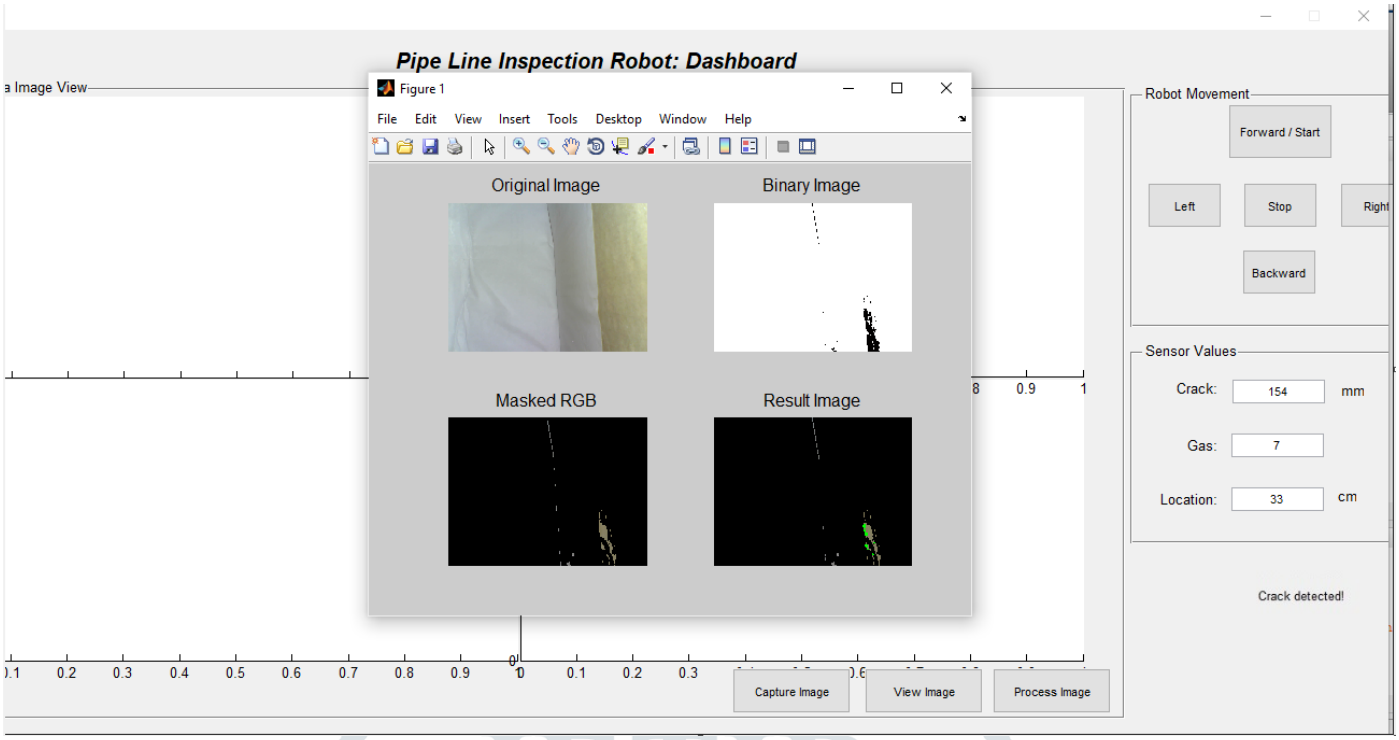

Fig. 5: Crack detection

The figure Fig. 5 shows the results for crack detection. For testing we have taken a pipe which has 65 mm distance from the ultrasonic sensor. If the ultrasonic sensor detects the distance more than that it means there is a crack. The same case is shown in the fig. 5. The Ultrasonic detects the distance as 154mm. Therefore, it shows the result as “Crack detected” and the location is 33 cm from start point of pipe.

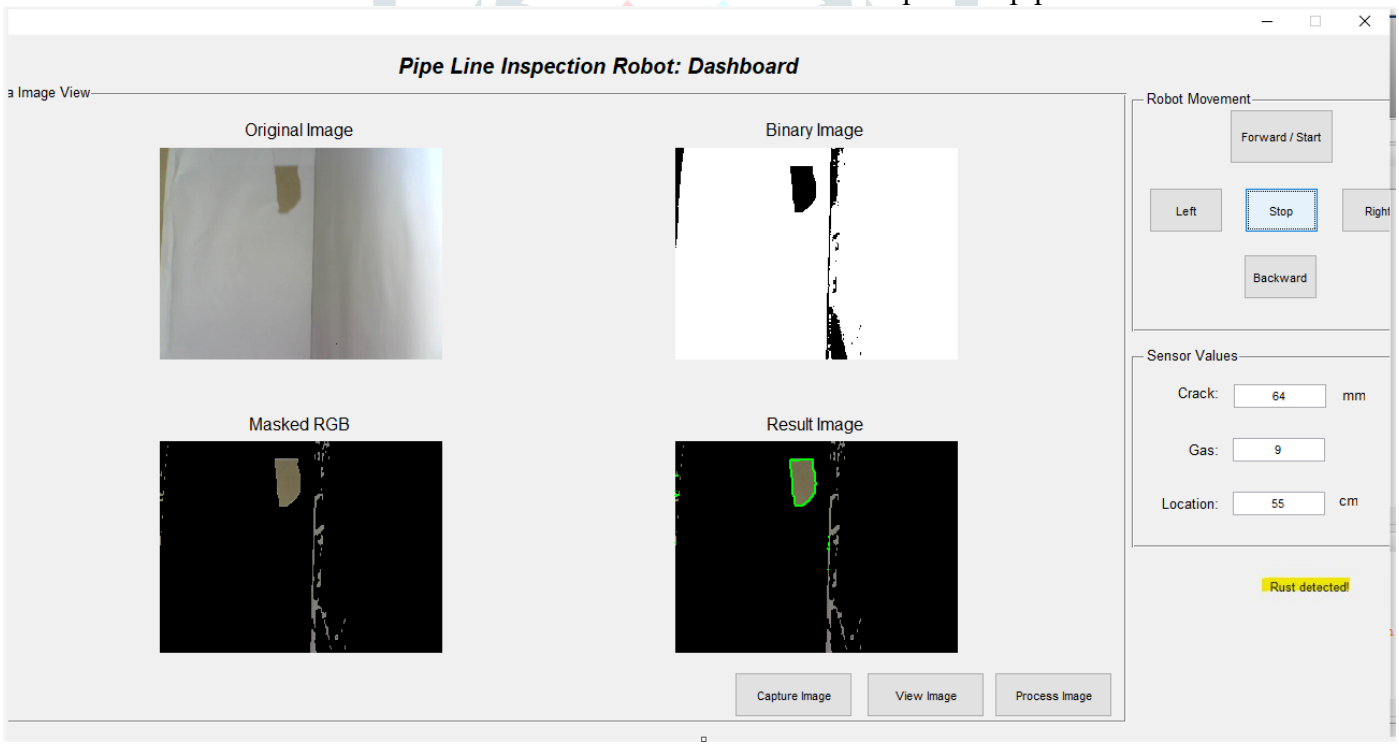

Fig. 6: Rust detection

The figure Fig. 6 shows the corrosion detection. The original image is a captured image of inside part of the pipe. This image is converted to binary image and then masking process is used to find the result image. The result image highlighted by the green border. The area of the green border image is more than the threshold, so it shows the Rust detected.

V. CONCLUSION:

Robots play a significant role in inside pipe-network maintenance and their repairing. The number of them were designed to understand definite tasks for pipes, and other may get wont to the structure function of the variation of the inspected pipe. We addressed the planning and development of a pipe crawler for inspection of water pipes. An outline of its rule, design details, and practical aspects are provided. As a future step, we glance to further increase in driving speed so as to boost the pipe inspection

efficiency. The varied kinds of inspection tasks are quite diverse. A modular design was considered so it may well be easily adapted to new environments with minor changes. The presence of obstructions within pipelines could be a difficult issue. The proposed mechanism solves the matter by utilizing a spring actuation and increasing the mechanism's flexibility. Several kinds of pipe inspection mini-robot modules are presented. Many of the Pipe inspection robot's design goals are completely met.

VI. REFERENCES:

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