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DESIGN AND MODELING OF AN INSPECTION ROBOT

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Abstract: There are some locations where humans find it difficult to reach for inspection; for example, a minor leak in an engine may be practically impossible to detect with the naked eye, but such minor faults will result in significant air accidents. We need to increase the quality of repair and inspection to reduce such errors. Humans may become tired and complacent over time, while robots do not. We may be able to have a better examination with a higher rate of accuracy if we use robots. As a result, we've presented a new concept for aircraft robot inspection that could serve as a second layer of inspection. Our research has the potential to drastically reduce the amount of negligence that occurs. With this study, we hope to make significant advancements in airplane inspection. These robots can also be used in pipeline inspections because they are equipped with a night vision camera that allows them to send video even when there is no light source inside, detect gas leaks, and determine the temperature of a given location.

Index Terms - Inspection, Aircraft, Pipeline, Robot, temperature, night vision, gas detection.

I. INTRODUCTION

Robots are designed to eliminate human interference from labor-intensive and hazardous work environments; they are also occasionally employed to examine inaccessible work sites that are difficult to reach by people. Pipe inspection falls under the same category since it transports harmful chemicals and fluids and, in most cases, has small internal diameters or bends that are inaccessible to humans. Because of the complex internal geometry and hazard content constraints of pipes, robots are required to inspect them in order to determine their corrosion level, recover useable components from the pipe inside, sample sludge and scale formation on the pipe internal surface, and so on.

Designing of an inspection robot is a difficult task and hence the designer must take care of all the design issues like Mobility, Steer ability, Turning radius, Size and shape adaptability, online adaptability, flexibility, stability, autonomous operation and obstacle avoidance, efficiency on uneven surfaces, and so on. operation in a safe manner selection of materials, Number of actuators, type of task to be performed inside the pipe, Operation in active pipe line, Retrieval of robot, User friendly navigation and control system, Range of operation and Quantitative analysis of defects inside the pipe.

The goal of this paper is to use the DTMF technology to control a robot. Although robots vary greatly in look and capability, they all have a mechanical, movable structure that is controlled in some way. Perception, processing, and action are the three distinct aspects of robot control. Preceptors are sensors attached on the robot that are processed by the on-board microcontroller or CPU, and the work is carried out with the help of motors or other actuators.

2. THE MAIN OBJECTIVE

- Can be inspected even if there is no light source.
- Can detect the leakage of gas
- Can determine the temperature and humidity of the specific place.
- Robot can be controlled through Bluetooth module.
- Determines the distance inside the pipeline.

3. COMPONENTS OF INSPECTION ROBOT

Raspberry Pi: The Raspberry pi is a single computer board with credit card size that can be used for many tasks that computer does, here it is used to play HD video. Raspberry pi works on LINUX operating system. The board not only offers a lot of functionality, but it also has a fast processor, making it ideal for complex applications.

IR-Cut Night Vision Camera Module: High Definition camera module compatible with all Raspberry Pi models. The camera module connects to the Raspberry Pi board via the CSI connector, which is developed exclusively for connecting cameras to the Raspberry Pi. The camera also has a 75.7-degree viewing angle and a 3.6mm focal length that can be adjusted. It can capture images with a 5MP resolution and record 1080p HD video at 30 frames per second.

ARDUINO UNO: The Arduino Uno is an ATmega328-based microcontroller board. It contains 14 digital input/output pins (including 6 PWM outputs), 6 analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. To get started, simply connect it to a computer with a USB wire or power it using an AC-to-DC adapter or battery.

HC-05 BLUETOOTH MODULE: The HC-05 Bluetooth Module is a simple Bluetooth SPP (Serial Port Protocol) module that allows for the construction of a transparent wireless serial connection. It communicates with the controller using serial communication, making it simple to use.

MQ-6 GAS SENSOR The MQ-6 gas sensor's sensitive substance is SnO2, which has a reduced conductivity in clean air. When the target flammable gas is present, the sensor's conductivity increases as the gas concentration rises. The MQ-6 gas sensor is highly sensitive to propane, butane, and liquefied petroleum gas (LPG), as well as natural gas. The sensor can detect a variety of flammable gases, including Methane, and is modest in cost and suited for a variety of applications.

DHT11 TEMPERATURE & HUMIDITY SENSOR: It offers high dependability and outstanding long-term stability by employing an innovative digital-signal-acquisition technique as well as temperature and humidity sensing technologies. This sensor connects to a high-performance 8-bit microcontroller and combines a resistive-type humidity measurement component with an NTC temperature measuring component, resulting in excellent quality, speed, anti-interference ability, and cost-effectiveness. The calibration coefficients are saved in the OTP memory as programmes, which are then utilized by the sensor's internal signal detection algorithm. The single-wire serial interface simplifies system integration. Its tiny size, low power consumption, and signal transmission range of up to 20 meters.

ULTRASONIC SENSOR MODULE: The ultrasonic sensor module for raspberry pi is used for distance detection. Ultrasonic sensors transmit ultrasonic waves from their sensor heads and then receive reflected ultrasonic signals from an object. The robot can virtually see and recognize objects, avoid obstacles, and calculate distances thanks to the ultrasonic sensor. The ultrasonic sensor's operational range is 2 cm to 450 cm.

ROBOT CHASSIS: The most important parts of the robot is the chassis. This piece connects all of the pieces and defines many of the robot's working features. A precisely engineered chassis, frequently custom-built for the purpose, lies at the heart of every successful robot.

L293D MOTOR DRIVE EXPANSION BOARD FOR ARDUINO: This is a popular DC motor drive module that employs the L293D chip and a low-current DC motor driver. The pins have been designed to work with Arduino, which is a simple to use platform.

CONSTRUCTION OF INSPECTION ROBOT

The Raspberry pi is connected with night vision Pi camera to get the daytime and night time videos. Insert SD card with Operating System into Raspberry Pi. Connect B-type cable to raspberry pi and USB cable to the computer; by this the power source is given to the raspberry pi, and then setup the internet connectivity using wireless. Now code the raspberry pi using python programming for live video transmission.

Now connect DHT11 sensor to raspberry pi and code using python programming that gives the values of temperature and humidity in the specific area. Connect two ultrasonic sensors to raspberry pi and code them in python programing to measure the distance. Both the ultra-sonic sensor is placed in the middle of the robot in opposite direction, each sensor measure the distance in the opposite sides, for example if the robot is sent inside a pipe for pipeline inspection, the ultrasonic sensors measure the distance in right side and left side and send the readings to raspberry pi, where the values are added and the diameter value is obtained. Using this method we can find the dents and shape variation in pipes.

Connect the Arduino Uno with Bluetooth module and gas sensor. Then code them using c programing, then install Bluetooth controller software in the mobile phone, and connect them with the Bluetooth module for robot access. The gas sensor detects the value and alerts if it detects any gas substance in air molecule.

4. ROBOT CHASSIS SETUP

Mount the Swivel Wheel: Install the swivel wheel by determining the top of the baseplate, which is not symmetrical. As a starting point, use the Arduino. Using the screws and nuts, secure the swivel to the bottom of the baseplate.

Mount the Arduino and Sensor Shield: Two screws secure the two spacers to the top of the baseplate. Using the other two screws, secure the Arduino to the spacers. Place the Arduino on top of the Sensor Shield. The right edges of the boards should be aligned. Ensure that each pin is connected to a connection.

Mount the Motors on the Bottom of the Baseplate: Solder one red and one black wire to each motor. Either of the terminals can be any colour. Place one tab in a slot on the baseplate's side, position the motor, then place the other tab in a slot on the baseplate's top. Connect the nuts with two screws from the outside tab through the motor and inner tab. Repeat the procedure for the other motor. Mount the wheels on the motors (Optional) Attach the optical interrupter discs on the inside axles.

Mount the Switch, the Battery Holder, and L298N: Insert the switch on the top of the baseplate between the two motors. Locate the battery holder on the underside of the baseplate just in front of the swivel and insert the two counter suck M3 screws into the leftmost and rightmost holes. One screw should be connected to the M3 nut, while the other should be connected to a spacer. A 5 mm M3 screw connects the other spacer to the baseplate. Pull up the three jumpers on the L298N board to remove them. With the two other 5 mm screws, secure the L298N board to the two protruding spacers.

Connect the 20-cm red wire to the other switch terminal with a soldering iron. The two left motor wires should be connected to the left connector on the L298N, while the two right motor wires should be connected to the right connector. The colours red and black don't matter here; if the robot moves backwards, reverse the colours. Connect two 12 cm lengths of wire to the battery holder's black (ground) wire and the power switch's red (power) wire. Connect the shield's "GND" connection to the doubled black (ground) wire. Connect the doubled red (power) wire to the shield's "VCC" terminal. Connect the shield terminal's black 12 cm cable to the L298N's middle screw terminal. Connect the shield terminal's red 12 cm wire to the L298N's left screw terminal.

RESULT

The design and modeling of inspection robot is completed and tested. This inspection robot can be controlled through mobile phone using Bluetooth module.

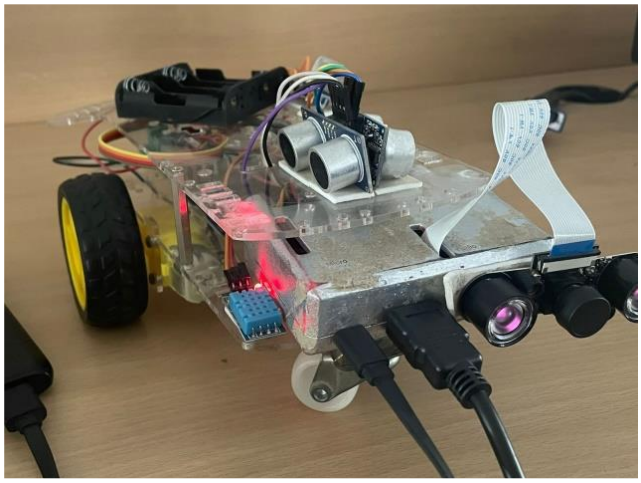

Figure1 Inspection Robot

Clear video can be obtained during day time and night time, using this feature we can inspect in area which has zero light sources.

Figure2 inspection video from day time and night time

- The breath or diameter of the model is measured.
- The temperature and humidity value inside the model is detected and data are acquired
- Using MQ-6 the gas detection values are acquired.

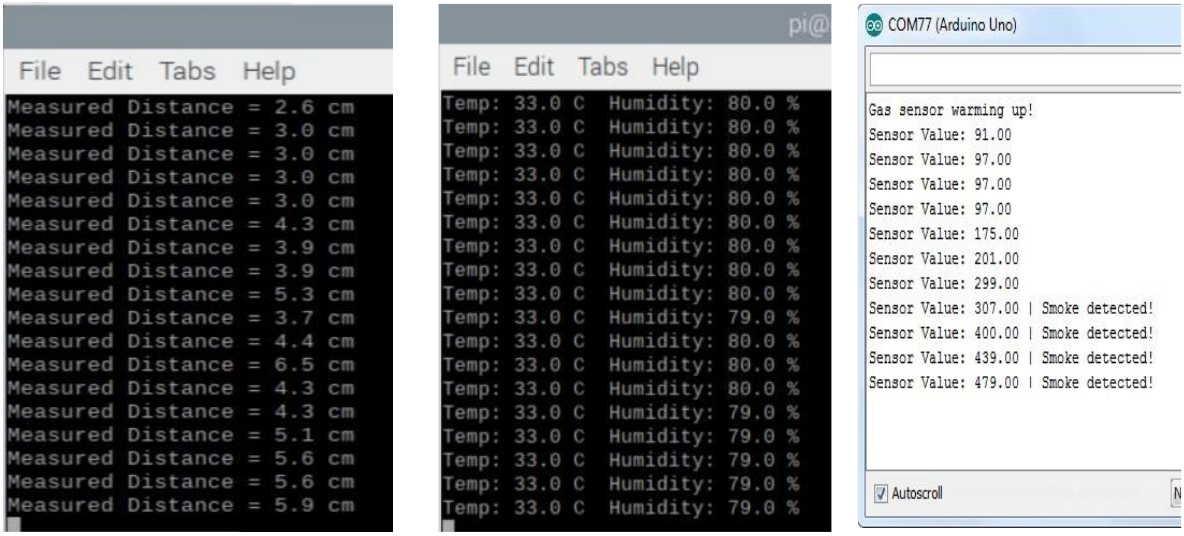

Figure3 Readings of distance, temperature and humidity and gas sensor

CONCLUSION

An aircraft inspection robot has been successfully designed and developed with suitable components. The Raspberry Pi, Arduino UNO and, the Sensors added so that the effectiveness of inspection has been improved. The IR Cut night vision camera helps us with the visualization of dark places within the fuselage prototype. The DHT11, Ultrasonic, MQ-6 measures and gives the values of temperature and humidity, distance, and gas leakage respectively. The robot has been successfully tested and the data's acquired were discussed. Therefore usage of the inspection robot in an aircraft will reduce the human error, negligence caused comparatively.

FUTURE SCOPE

The project's future scope is constrained in various respects, although it can be expanded by adding new features and applications. Listed below are a some of the improvements that can be made.

Implementation of raspberry pi for obtaining the gas values in the remote areas without using any wire sources. Use of Lidar sensor that scans 360 degree and obtain a data of surface and the obstacles and two-dimensional data.Using a higher level processor unit to reduce the delay in output result.

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