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Material Deformity Detection Bot

Ananya Das[1], S. Suhasini [2]

1(Department of Electronics and Communication Engineering, SRMIST-Kattankulathur, Tamil Nadu, India)
2(Department of Electronics and Communication Engineering, SRMIST-Kattankulathur, Tamil Nadu, India)

Abstract:

In this paper, we discuss an intelligent inspection system that uses a robot and some IT technologies in order to acquire certain information such as deformity of a material. It can be used to manage the condition of railway tracks wheel axle, pipelines, buildings or bridges. Uneven surfaces, cracks, abnormal temperature conditions, rust formation, etc. causes deformity in materials and can prove to be hazardous. It is very necessary to detect these deformities in time for safety purposes. There are a variety of sensors available that can be used for detecting such deformities or abnormalities. These sensors can be integrated with a low cost, simple robot based on an embedded design for such purpose.

Keywords **— Crack detection, sensors, Bluetooth module, embedded design.**

I. INTRODUCTION

Non-destructive testing of materials for abnormality detection is being carried out since long but most techniques used at present require the presence of human workers at the site for monitoring. Therefore, it is necessary to develop modern techniques that employ automatic monitoring especially for the sites which are inaccessible to humans. For example, monitoring any hazardous zone where human exposure should be prevented or very narrow places like long pipelines with small openings or monitoring structure of bridges from different angles.

In this paper, to design an effective deformity detection system we use a small robot which is based on an embedded platform. The design of the robot is interfaced with a microcontroller, sensors, motor, and IT technologies. These components are placed on a single board. Ultrasonic sensors are used to detect cracks on materials. Temperature and other sensors can also be included in it.

The idea is that the mobile robot would move along the material to be monitored and in case any abnormality is detected, it is communicated to the authorized person and displayed on a monitor.

RF communication can be used for this purpose. An alert SMS can also be sent to the authority through GSM. The mobile robot has to be programmed in such a way that it avoids obstacles. This system can also be used in places that are inaccessible to humans. These ideas are based on the existing works on deformity detection systems. They are as stated below.

K. Saritha and Ch. Lavanya, in their paper "Embedded Based Crack Inspection and Mapping System for Railway Track Maintenance by using Robot", have mentioned about the embedded based crack detection robot that they had developed for crack detection in railway tracks using IR sensors and LASER diodes and which displays the information of the cracks using LCD displays [1].

Rony Roy, G.Gokulkumar and M.Varatharaj have discussed in their paper titled "A Smart Mobile Robot to Detect Abnormalities in Hazardous Zones" about the need for early

detection of abnormalities in hazardous zones and have developed a mobile robot with sensors to sense its surroundings and the ability to avoid obstacles [2].

Mrs. V. Mahalakshmi and Dr. K.O. Joseph have mentioned in their paper, titled as "GPS Based Railway Track Survey System", about a railway tracking survey system that they developed based on GPS where a robot is used to detect cracks in railway tracks and immediately notifies the current train through wireless technologies [4].

Rui Wang and Youhei Kawamura have developed a climbing robot for the inspection of steel bridges using non-destructive technologies, which is mentioned in their paper: "An Automated Sensing System for Steel Bridge Inspection Using GMR Sensor Array and Magnetic Wheels of Climbing Robot". This robot can be used to determine the properties of structures [5].

Some applications of the material deformity bot are:

- Deformity detection of any surface, e.g., roads
- Inspection of material uniformity
- Inspection of wheel axles, pipelines, railway tracks, etc.

II. TECHNICAL SPECIFICATIONS

The basic components used in the project are:

- Arduino Uno Board
- Motor Driver L298N
- Ultrasonic Sensor
- Bluetooth module HC05
- Servomotor
- Buzzer
- 9V Power Supply

The software module used to program the Arduino board is Arduino IDE.

III. DESIGN METHODOLOGY

The robot is operated using the power supply and moved along the surface under inspection using motors. Ultrasonic sensors are interfaced with the micro-controller in order to detect uneven surfaces. These sensors that are attached to the front of the robot would keep on monitoring the surface on which the robot moves.

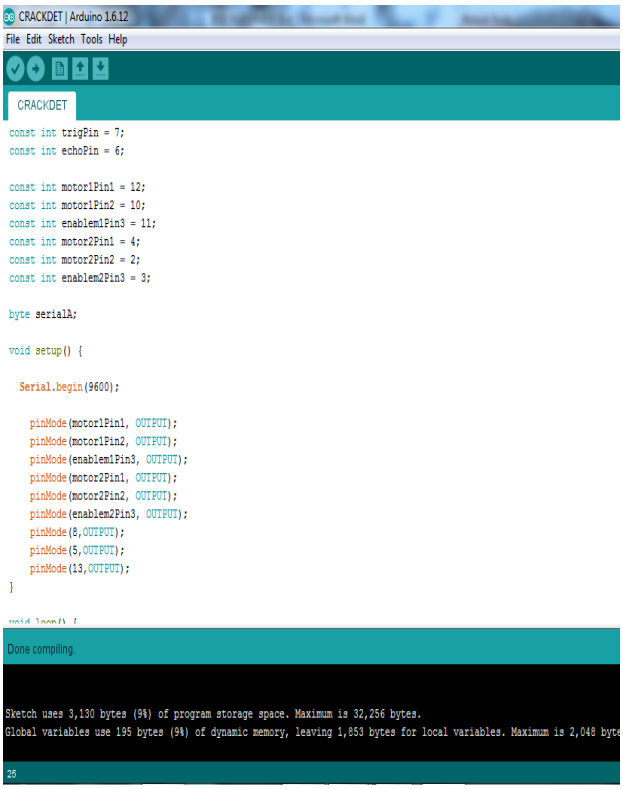

Fig. 1. Simulation result of compiled code in Arduino IDE.

The moment the robot encounters an uneven surface or crack, the sensors would sense it and signal (LCD display or activate buzzer). A Bluetooth module is interfaced to the microcontroller in order to immediately send the information of any abnormality that has been detected, to the concerned authorities. The information about the cracks will also be displayed on the LCD display that will be connected to the robot.

This can be a very easy and cost-effective way to detect surface abnormalities of structures like railway tracks, bridges, pipelines wheel axles, etc.

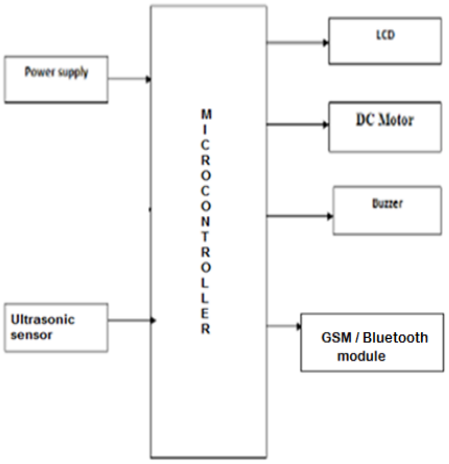

Fig. 2. Block Diagram of a crack inspection system.

IV. ADVANTAGES

Some advantages of using crack detecting robot are as follows:

- We can use this to detect cracks in railway line, pipelines, wheel axis and in other applications in oil drilling.
- It's a low-cost initiative through which very accurate detection can be achieved.
- It prevents accidents by limiting human exposure.

V. RESULT AND DISCUSSIONS

When the power supply is turned on and the robot is made to travel over any surface, we can observe that if the surface has no deformities then the robot moves smoothly over the surface without any interference and therefore it does not display alert messages or give any warning but as soon as it encounters a deformed surface it reacts by giving an alarm signal and sending a warning message.

The robot successfully detects any minor cracks or bumps on any surface and other sensors can be attached to it in order to determine several other properties of the material or the surface under test.

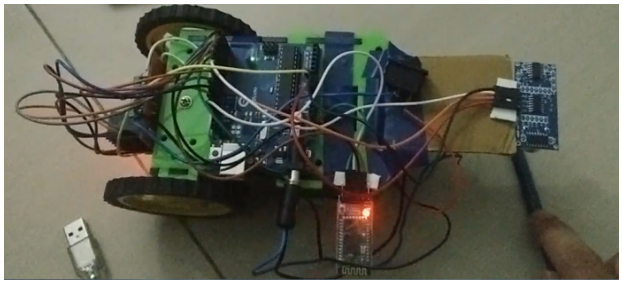

Fig. 3. Project Model for crack detection.

VI. CONCLUSIONS

We have created a simple robot using sensors which can have many real-life applications. For example, we can use this robot to detect cracks in railway lines, buildings or pipelines and other applications in oil drilling. It's a low-cost initiative through which very accurate detection can be achieved. It would prevent accidents by limiting human exposure. Thus, we can use a very simple and low-cost robot for automatic deformity detection.

There is much scope for this project in future. The deformity detection robot can be developed to detect many other parameters that are required for the safety of a structure and better technologies can be used in it in future. It can also be designed to climb and walk on uneven surfaces or enter very narrow regions.

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