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Review on Track Cleaning and Crack Detection Machines

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Abstract: ***The paper reviews the journalism available related to railway track cleaning and track crack detection machines. The usual cleaning and crack detection process of the tracks is manual, which is hectic and far from the desired level of cleanliness and safety from train accidents. Due to this reason, human workforce is required which consumes a lot of time and most of the labours risk their health to clean the tracks. Also, existing machines are bulky and require frequent maintenance. This paper discusses the various systems to overcome the above problems.***

Keywords: Cleaning, IR sensor, vacuum system, mechanical cleaner, nozzle, solar, etc.

I. INTRODUCTION

Indian Railways transport millions of people every day through its wide network of thousands of trains all over India. It has emerged as one of the fast-growing and profit-making organizations in the country. But one thing which needs desperate and immediate notice is “sanitation in Indian Railway premises”. The trash from pantry cars and tray loads of hot meals at the station and in the train often is thrown away through the doors and windows of bogeys onto the tracks fouling path along the way of the train.. The current cleaning process is mostly manual and most of the labours risk their health to clean the tracks also, it is very time consuming. Railways also have employed the cleaning machines for the same but, they are costly and they use water nozzles which requires lots of quantity of water that’s why instead of collecting and cleaning the garbage, these machines tend to litter it. Another concern is that, due to insufficient maintenance and the currently erratic and manual track line monitoring that is being carried out, certain railway track cracks usually go unnoticed. Because of this passengers’ safety goes on risk and chances of train accidents increase drastically. That’s why along with cleaning, crack detection is also an important factor. Current review summarizes research and investigation on the various models and systems related to overcome these cleaning and cracks related issues.

II. LITERATURE REVIEW

Suvi Santa-aho et al. [1] have reviewed on various recent utilization of ultrasound-based inspection system which are capable of searching for the inner defects that lie under the surface of rail track. The results of multiple ultra-sound probes are made using Glassy-Rail-diagram in which the colours represent the amplitude of the reflected signals giving a fixed resolution independent of the inspection speed. The ultrasound probes are generally located in rotating wheels or in sliding shoes/runners also called a sliding plate sled. Fig 1 shows the schematic presentation. The Ultrasound unit which is located on the sliding plate sled which may achieve a gap of around 2mm between rail head and the probe shoe. Some of the rail defects were difficult to detect due to their shape or orientation, thus the defect must be oriented at 90 Degrees to one of the search beams used to acquire the defect. With higher frequencies, detection of smaller flaws increased but the consumptions of ultra sound energy also get increased. There were more restrictions for measurement speed in case of a fluid filled roller search unit. The field test was carried out at about 40 kmph since the actual measurement speed was 60 kmph due to ultrasound physical limitations. In addition, they reviewed the future techniques that have not been automated or used in routine inspection.

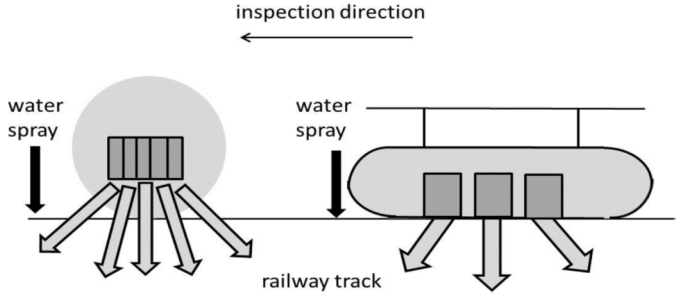


Fig. 1 Arrangement of various probes in rotating wheel and sliding plate sled

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Novel Kumar Sahu et al. [2] had done work on speed-controlled railway track cleaning system which would give a solution to the open toilets and option for Indian Railways to make a clean and Hygienic Environment especially on Railway platforms. When the train reaches a certain level, the waste from the chamber is discharged from the discharged valve and the valve is automatically closed when the speed is less than the predetermined speed. Referring Fig. 2, we can see that the system operations depend on the speed of AC motor and speed of governor for controlling the operations. After evaluation, they found that when the train reaches a minimum speed of 45 km/h, the gate begins to open and is completely opened after reaching a speed of 70 km/h.. One approach for modification was that adding the anaerobic bacteria to the tank so that there will be less environment hazard but this cost a lot thus need for increasing the size of tank. So that there would be no restrictions on the passengers.

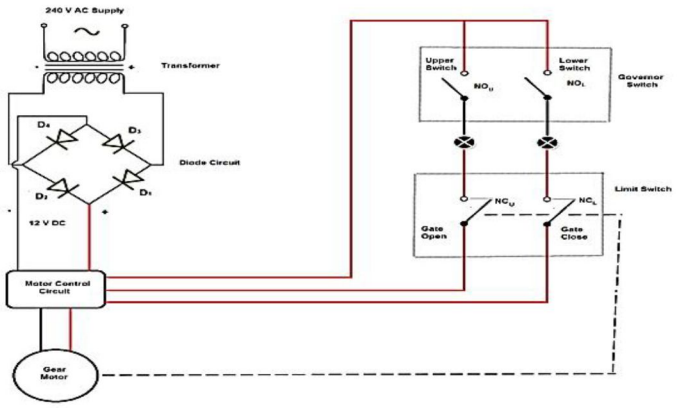


Fig. 2 Circuit Diagram

Jesin James et al. [3] have concluded the work on Intelligent Track Cleaning Robot. A scenario that requires urgent remedy is the fact that humans have to clean human waste and other litter thrown on rail tracks. Many of those working in this job suffer from similar health issues. To prevent this condition to some extent they use robotics and control technology. In this system, the feeder unit is fixed in front of the robot chassis. Feeder unit encompass 4 rotating blades that increase efficiency of cleaning. Every blade is equipped with flexible bristle at the end. The blades material is aluminium sheet metal of 3mm thickness. As shown in Fig. 3, it consists of a four-wheel strolling robot with a suction unit which includes Vacuum Pump positioned on both sides to clean the sides of rail-tracks. The pump operates with 220V and 50Hz power-supply so, the battery energy is stepped up, converted to AC source and fed to the vacuum pump. Cleaning unit with pressurized water to get rid of sticky wastes and human waste that still remain on rail tracks. The water unit Pressure needed is 2psi. The capacity of storage tank water was 6 litres. The flow rate from the tank should be 0.2liter/minute so that the tank could supply water for 30 minutes. The Chlorination unit is placed at the back side of the robot which will clean the tracks and remove foul odour. Chlorine powder, along with forward motion, was sprayed on rails. The tank was having 4kg of chlorine powder after 10 minutes of single run. It also consists of an intelligent control system, an intelligent train sensing unit and power unit. The Robot is made to run on a 500-meter track, it took 10 minutes to complete the entire process. This device is the primary of its type proposed to be developed exclusively for the Indian Railways.

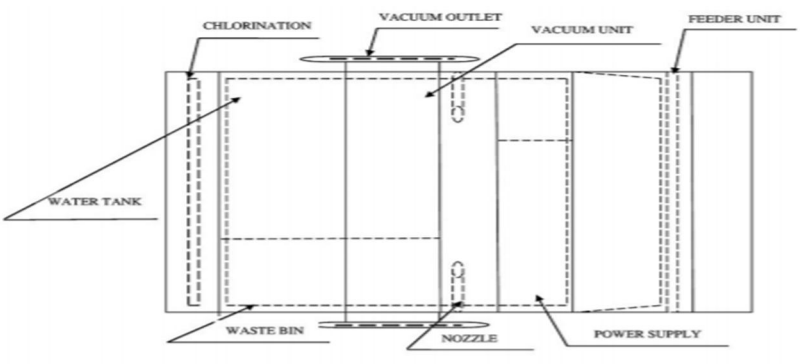


Fig. 3 Top View of Model

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Sushil Vijaykumar Deshpande et al. [4] have represented work on Robot based mechanism cleaning between Railway track, according to his work, this paper aims to present a Robot Based mechanism for cleaning between the railway track. Vacuum technology is used in this mechanism. When the robot started the rotating front brush and side brush in this method, it tried to accumulate the waste that was thrown in the direction of the front vacuum duct, like plastic, paper, waste, etc. The remaining left out between the rotating front and side brush is also limited by the stationary side. Capacity of Vacuum pump was 18litre and max water capacity was 12litre. Vacuum pressure was around 200mbar. The control panel controlled the travel speed and direction of robot, On-off condition of robot & DC motor switch on/off (brush & vacuum motor). Suction motor power range was between 1000-1200 watt. The working of robot was conducted in two cycle (dry cleaning and wet cleaning cycle). The dry-cleaning cycle and wet cleaning cycle frequency were calculated as required. The water spraying manifold was situated between brush assembly to conduct wet cleaning cycle. All climate conditions have been tailored by this mechanism. We may connect it to an existing train compartment or to a separate engine.

Nehal D. Jadhao et al. [5] performed the work on, Review Paper on Automatic Railway Track Cleaning Machine, according to their work, India is travelling towards the dream “clean and green” and so they tried to implement cheap but efficient rail track cleaning system to overcome the garbage problem along the tracks. Their cleaning and maintaining vehicle for the track mainly consists nozzles, rollers, water tank, reservoir and suction pump, brush, solenoid valve, IR sensor, etc. which can be seen from the Fig. 4. The nozzle was used to control the direction and characteristics of the flow of fluid (especially to increase the velocity) as it exits the enclosed chamber or pipe. They selected nozzle based upon the flow rate, spray angle and spray width. The nozzles are 20°-30° inclined to the vertical axis. Water is sprayed at a pressure of about 15-30 bar. In this, they implemented high-pressure water jet to spray the water through nozzle on the track and the suction pump is used to suck the garbage which is below the track. The IR sensor is used for the obstacle detection having range of 2-4 ft. This system also cleans the portion which is beside the track by applying high pressure water on the track. This machine is battery charged and electronic control unit is used for the automatic handling of track cleaning machine.

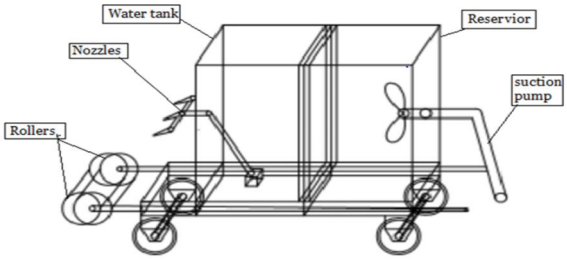


Fig. 4 Schematic Diagram of System

P. Vamsi Krishna et al. [6] presented work on Intelligent Railway Track Cleaning Robot with Waste Segregation. In this paper they worked on a new idea for smart and safe cleaning of railway tracks as old method are inefficient and unhealthy to workforce. According to their survey every train produces 1100 plates, 1750 cups and 800 various plastic items on daily basis and human waste is thrown on railway tracks later clean by workforce. They have worked model of smart robot consist of Permanent magnet, Ultrasonic Sensor, Motor Driver, Chlorination units and Microcontroller which is shown in the Fig. 5. Robot’s cleaning system runs on railway track using retractable wheel system and collects the waste using Magnet for Metal particles like Iron and a vacuum arrangement to clean materials like plastic, paper, etc. Post cleaning operation the chlorinating water is sprayed from holes in back of robot, simultaneously the ultrasonic senor checks the track for presence of any defect or cracks on the surface. All the process are carried out with the help of Arduino controlled which is programmed in C++ language. Their aim of the system was to provide a better approach to the safe and healthy atmosphere and surrounding problems.

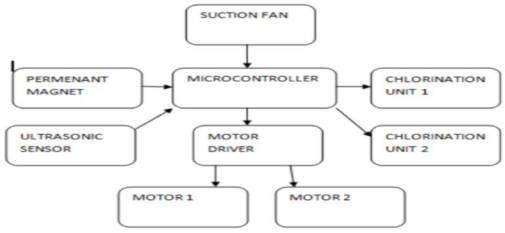


Fig. 5 Line Diagram of System

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Chaitra T A et al. [7] did the work on, Intelligent Railway Track Scavenging and Crack Detection Robot. It is an intelligent vehicle that goes on the track which consists of four-wheel running robot with a Power supply unit, cleaning unit, sprinkler unit, Dual Tone Multi Frequency (DTMF) control unit, obstacle sensor unit, signalling unit, crack detection unit. A 12 V DC supply is used for the functioning of the robot and 3.3V DC supply is used for microcontroller. They employed a nylon brush to clean in between the track with the help of DC motor which rotates 360 degrees and pushes the waste towards the bin. There is a container to hold mixture of water and disinfectant. The controller ARM7 LPC2148 are based on a 16bit/32bit ARM7-TDMI-S CPU. This robot moves with the help of continuous track tyres, cleans, and collects the waste accumulated between the tracks. It detects the crack in the track as well as detects the obstacle present in front of the robot, sprinkles the mixture of water and disinfectant continuously after cleaning. Based on the interrupt received when there is a crack, the robot automatically gets stopped. It gives red signal indicating that the robot is in cleaning process and gives green signal when cleaning is completed. They didn't use vacuum system instead of brushes to suck the waste.

Karthikamani R et al. [8] have suggested the sensor-based application model for railway track that improves the safety of the travellers travelling in the train. To get rid of such dangerous situation and accidents sensors are used for crack detection and safe journey. Many techniques are implemented such as crack detection using vibration sensor, obstacle detection using IR sensor, crack and obstacle detection using laser, image processing etc have been used. But this proposed system came out with idea of using PIR sensor and electrochemical fatigue sensor for obstacle and crack detection. This system is included with three model which are Sensor module, processing module and transmission module. In sensor module they have connected two PIR (Passive infra-red) sensors and electromagnetic fatigue sensor as shown in Fig. 6.1 and Fig. 6.2. These sensors were used to the sense the obstacles and cracks in the railway track when the train is in moving condition. PIR can work nearly to 10 meters. Electrochemical weakness sensor is used to distinguish the breaks with the steel objects. In processing module, they have used Raspberry pi which is utilized to process the information from sensor. Transmission module was proposed for transmitting the handled information to the mobile phone. The information is transmitted to the prepare designer's close to home cell phone through GSM. This proposed framework was exceptionally anchored, financially savvy; less power expending.



Fig. 6.1 PIR sensor

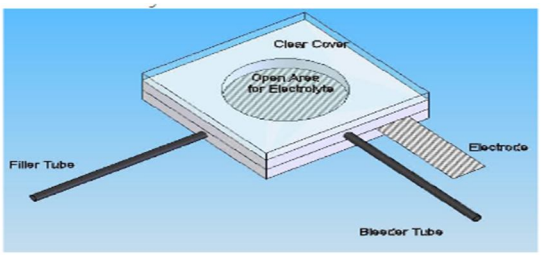


Fig. 6.2 Electrochemical Fatigue sensor

Balasaheb Kasure et al. [9] put major focused on Semi-automatic track cleaning machine. The usual toilets in the trains are small compartments with a hole which directly dispose the waste on to the tracks thus polluting the areas within the railway premises, streams, rivers, etc. They came up with a machine with an overall idea of the problem that can do the job effectively and efficiently with a solution to their short coming. Such that there will be saving of water and labour charges which are included in the costings. Some vital functionality was achieved in the waste clean-up on railway tracks, and they also tried to find a solution to related problems by keeping the log of cleaned and uncleaned area in the secondary storage. Referring fig.7. The major limitation in the creation of a cleaning robot is its size, as it cannot sustain its versatility without a minimum size. Cleaning System offers an effective cleaning method which can be used during emergency and seeks to minimize human efforts by dirt-free railway tracks.

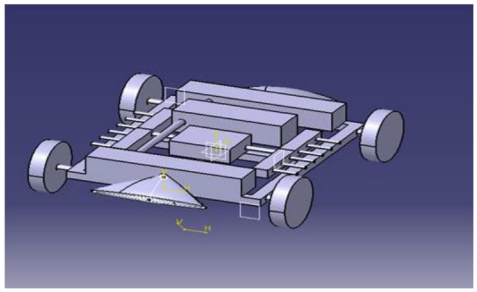


Fig. 7 3D Model of Robot

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Prof. Shyam Agrawal et al. [10] presented a work on an Arduino based approach to detect cracks and obstacles in the way of railway tracks. The presented work consists of an Arduino atmega328.arduino which is an open-source electronic hardware as a microcontroller. It can be seen from the Fig. 8; various components are attached in order to detect cracks. The Ultrasonic sensor having range of 100 cm and put off 30 cm also a bumper sensor and infrared sensor is used to detect the obstacles. The mobility of an automobile was controlled by ultrasonic indicator as to move it left, right, back and forth. To control rate of motor pulse width modulation (PWM) was implemented. The IR LED, photodiode along with Ultrasonic sensor stops the motor as it detects the crack and send SMS to the nearby station or at specific cell phone address the exact GPS co-ordinates with the help of GSM module of industrial grade which has SIM card and operator with subscription. To move this automobile geared DC motor is used to get more rpm using same voltage. A l293 and l293d are quad push pull drivers having output contemporary 1a or 600ma in step with channel were used. They concluded an inexpressive, high power efficient system which detects cracks and obstacles.

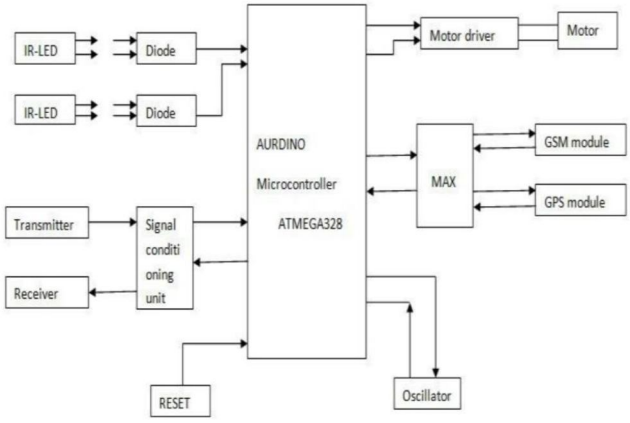


Fig. 8 Line Diagram of System

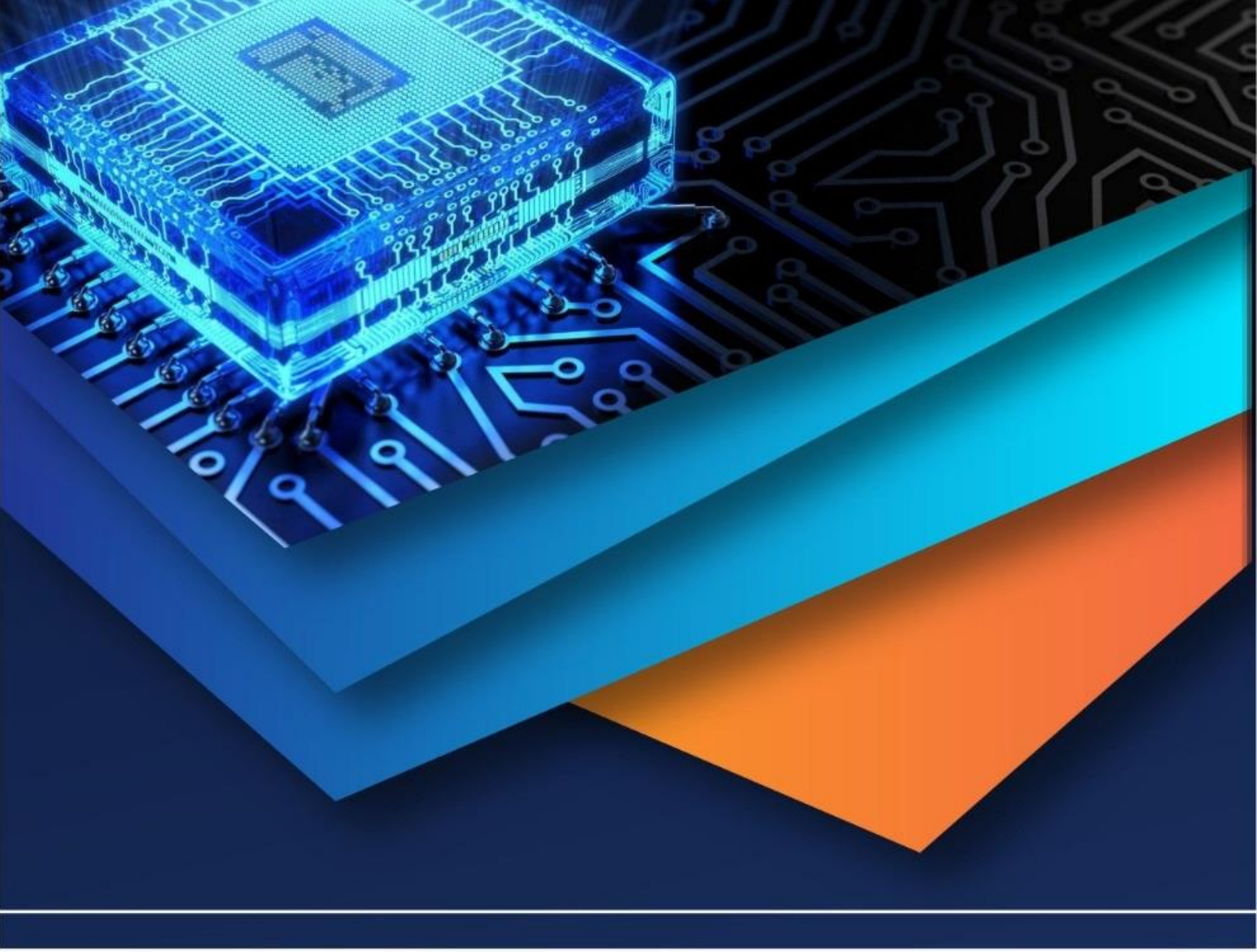
III.CONCLUSIONS

The above research and review papers provide concise information about various alternative methods so far to avoid the major problems related to unhygienic rail track areas and health related issues. It is possible to detect small cracks along the track line by introducing such system which will gradually reduce the risk of rail accidents. With the help of CAD models, line diagrams and circuit diagrams, simple explanations are shown where needed. Thus, it can be summarized from above study that there is a constraint for the size of the model, but using proper systems reduction in time for detection of crack along with cleaning of track is possible using brushes and vacuum system so that efficient cleaning within the tracks could be achieved and proper maintenance of tracks with good hygiene could be ensured.

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