

# DESIGN AND FABRICATION OF SELF-PROPELLED RAIL CRACK INSPECTION ROBOT

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**Abstract** - The Indian Railways currently uses Self Propelled Ultrasonic Rail Testing (SPURT) cars for detecting cracks. The main problem that arises in the current inspection systems are increasing man power, greater time consumption and the difficulty in train passage scheduling. The self-propelled rail crack inspection robot can be programmed to run from one station to another. When a train approaches, the robot uses a mechanical arrangement, so that the entire robot rest in between the tracks with the help of electromagnet provided in the base plate of the robot. The Robot is wireless and automatic, and it requires no human effort during its operation. The project includes both design and fabrication of the robot. The modeling software Solid Edge ST9 is used for designing the robot along with various machining operations were performed for the fabrication.

The robot employs 2 servomotors, electromagnet and vibration measuring system.

## 2. OBJECTIVE

The objective of the present work is proposing a new model for detecting cracks in the railway tracks, which is automatic, faster and efficient than the previous system thereby creating a revolution in the railway inspection system. The robot which do not disturb the passage of trains and also able to fold and retain itself when train approaches. Reduce the human effort considerably saving time and energy. Response quickly as possible using electronic circuit thereby, maintaining the scheduling time of trains. Prevent derailment caused due to cracks, making the railway system trust worthy and to ensure safety of human life. Robot should be Easily Assembled and Disassembled.

## 1. INTRODUCTION

Today, in the real-time world, so many types of transportations are available but majority of the people prefer to travel by train, because its price economy and it is comfortable. At present The Indian railway network has a track length of 115,000 km and 7500 stations. It is the fourth largest railway network in the world. That means one of the biggest railway network system. However, when it comes to safety, we are not. The present inspection system is outdated. According to the Indian railway's annual report, there were 139 consequential train accidents during 2010-11, and 165 during 2009-10, both major and minor. Most of these accidents were the result of unhealthy track inspection. GANGMEN are the people who inspect the railway track. Therefore, the Railway always put the blame on them. However, the real fact behind, is the outdated inspection system and not the fault of the gang men.

The Self-Propelled rail crack inspection robot is an automatic unmanned robot with wheels, which provides easier crack detection without causing any disturbance to the train passage on the testing tracks. This robot continuously inspects cracks in the tracks while moving, using ultrasonic waves. The robot has a vibration sensor, which senses the train arrival with the vibrations and will actuate a circuit which in turn employs a mechanical arrangement. Then the entire Robot folds to the space between the tracks and rest there with the help of electromagnet. Here a rack and pinion arrangement is used for wheel disengagement to provide an undisturbed way for the incoming train. After train passes the Robot, it automatically returns to its original position.

## 3. MATERIALS AND HARDWARE PARAMETERS

**Table -1:** Materials and hardware parameters

SL NO	COMPONENT	DESIRED CHARACTERISTICS	PREFERED MATERIALS
1	Rack and pinion	Light weight, Lesser volume and Space	Nylon 66
2	Gear and supporting accessories	Greater machinability, less weight and greater load carrying capacity.	Nylon 66
3	Servomotors	Lesser weight, high torque and less rpm.	10rpm 12v DC Motor
4	Chain and Sprocket	Greater Strength and No slip	Steel alloy
5	Plates	Less weight capacity without bending and better machinability	Nylon 66
6	Casing	Weather resistant, lesser weight and greater machinability.	Sheet metal
7	Nuts, bolts, screws, washers and rivets	_____	Mild steel
8	Ultrasonic generator and receiver module	Simple, compact and cheap	_____
9	Vibration sensor and comparator circuit		
10	GPS system		
11	Inspection circuit		
12	Batteries	Lighter weight	Lead acid

#### 4. DESIGN

Two stage of design procedure carried out. Primary stage, made a 2D draft of robot frame work design using solid edge ST9. Then the secondary stage made the modelling of robot assembly

##### 4.1 2D DRAFT USING SOLID EDGE ST9

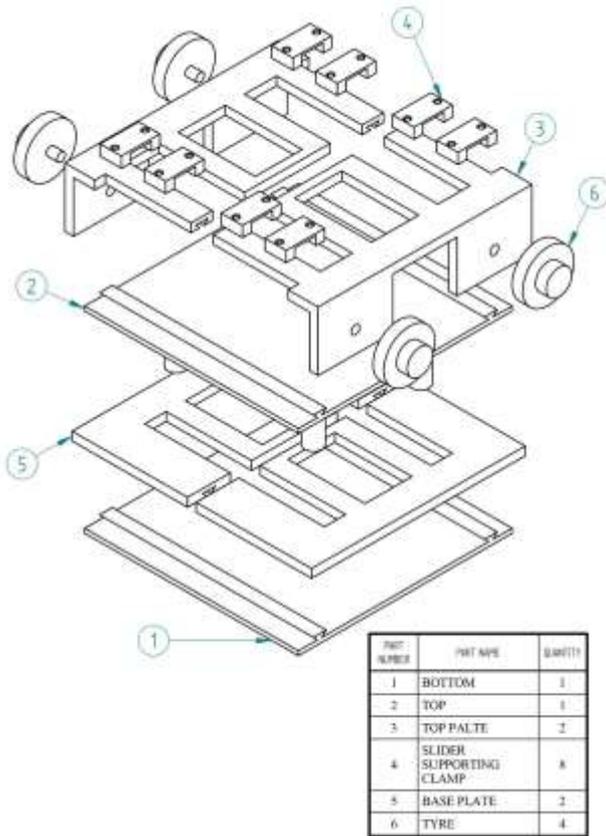


Fig -1: Draft of Robot Assembly

##### 4.2 3D MODELING USING SOLID EDGE ST9

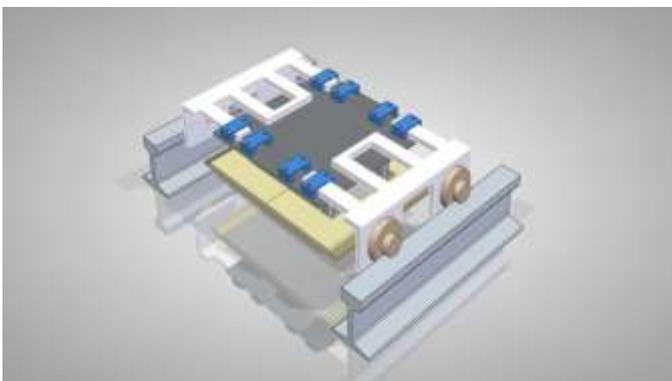


Fig -2: ISO Metric View

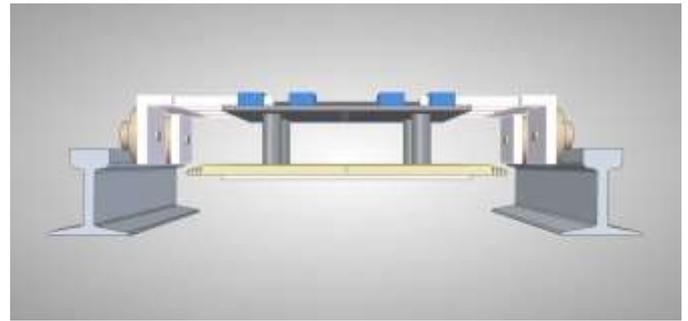


Fig -3: Front View

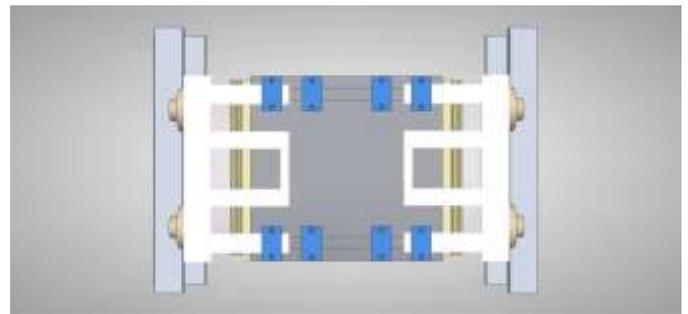


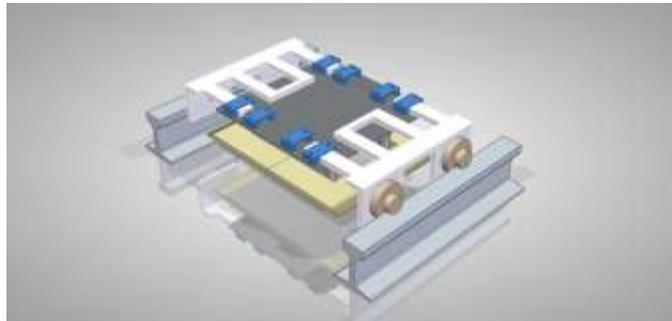
Fig -4: Top View

#### 5. WORKING PRINCIPLE

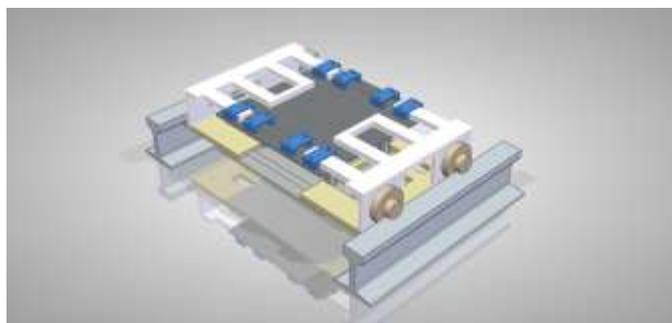
The Automatic rail crack inspection robot is an automatic unmanned robot with wheels which provides easier and faster crack detection without offering any disturbance to the train passage on inspection of tracks. This robot continuously inspects cracks in the tracks, using ultrasonic waves. The robot has a vibration sensor which senses the train arrival with the vibrations of tracks. It will actuate an electronic circuit which employs a mechanical arrangement so as to shift the entire vehicle from the tracks to the space in between the tracks. Here a rack and pinion arrangement are used for wheel disengagement so as to provide way for the incoming train. The robot employs two servomotors and electronic circuit system for detection of cracks.

The robot has 3 major parts; Top, Bottom Plate and Housing Frame. The housing frame functions as a housing for the electric circuit, motors etc. The bottom plate having large number of windings in each side which provide electromagnetic field. While inspection, the train arrival is detected by using the vibration sensor. The motor 1 gets actuated and thereby the rack and pinion arrangement on the bottom plate gets enabled. There by bottom plate Move to words rail track side. Once the movement completes, Bottom plate gets stuck on the underside of track firmly by the help of electromagnetic field. After this, the motor 2 gets actuated and thereby the rack and pinion arrangement on the top plate gets actuated, which folds the wheels linearly. There by the robot gives a safe passage for train without any disturbance. After the train passes the robot, the mechanical arrangement reaches its initial position by reverse motion of

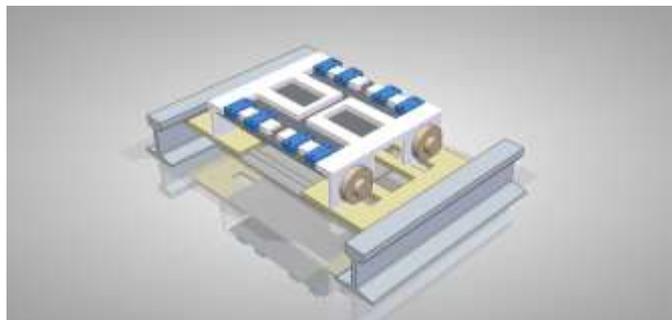
the servo motor. The next servo motor is used for propelling the vehicle forward and backward. While inspecting if the robot detects any crack on the rail, it sends a message to control room and the message contains accurate information about the position of crack.



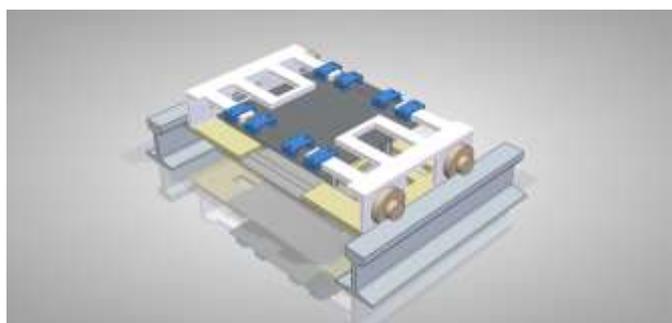
**Fig -5:** Initial Inspection position, wheels on track



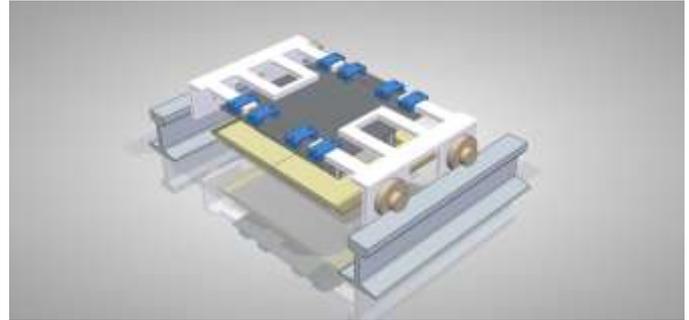
**Fig -6:** Bottom plate movement, when train approaches



**Fig -7:** Top plate movement, which give passage to train



**Fig -8:** Top plate back to position, when train leaves



**Fig -9:** Bottom plate back to position, continues inspection

## 6. CONCLUSIONS

The self-propelled rail crack inspection robot continuously inspects the cracks while moving on the tracks. This robot employs an ultrasonic wave for efficient crack detection. During inspection, if any cracks detects it will immediately send a message to the control room along with the inspected track details. Also, the robot will not disturb the passage of trains by the suitable mechanism. So that the entire robot will rest in between the tracks with the help of folding and retaining mechanisms.

The folding arrangements and mechanism of the robot were designed. This includes the identification of the folding/Gear arrangements to have the desired motion. The materials and hardware characteristics were selected, and the defects developed in the rail tracks were studied.

The model of the robotic parts was fabricated. Then the supporting accessories such as wheels, pullies, rack and pinion, chain drive were selected along with the appropriate servo motor, the power sources (battery) were incorporated. Then the replica of railway tracks and other accessories were fabricated and assembled. The electronic circuits were selected and programmed using required components with the help of experts.

## 7. REFERENCES

- [1] Krishanu Gupta; NIT Agartala, Sushovan Chatterjee; NIT Silchar, "Analysis of Material Selection of a Spur Gear Pair for Solar Tracking Applications".
- [2] Textbooks and Internet Resources.
- [3] PSG Design data book.