Automation of Railways

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Abstract— In India, rail transport occupies a prominent position in providing the necessary transport infrastructure to sustain needs of a rapidly growing economy. Today, India possesses the fourth largest railway network in the world. However, in terms of the reliability and safety parameters, we have not yet reached truly global standards. This can be improved using certain smart techniques. This paper focuses on cost effective solution of generating voltage from renewable energy resources. Also, railway accidents will be avoided by providing automatic level crossing gates and crack detection on railway tracks. The voltage generated will be used for operation of the level crossing gates. Thus the system will use the generated voltage for its operation, hence the name smart railways.

Key words: Energy Generation, Automatic Level Gate Crossing, Crack Detection

I. INTRODUCTION

Railways are a very important mode of transport in the modern world. And it has been in a constant stage of improvement since its inception. The next step to its improvement is providing it with automation. Nowadays the demand of energy is increasing day by day, so the ultimate solution to deal with this is just to implement the renewable sources of energy. Thus, the first objective of this paper is power generation through human pressure as a source of renewable energy that can be obtained from the vibrations caused by the railway freight and wagons at level crossing. The conversion of human pressure to voltage will be done by the use of piezoelectric crystals and flywheel method.

The railway gate automation system aims to deal with two things. It reduces the total time taken for the gate operation at the level cross and also ensures the safety of the passengers at the level cross during when the train passes. The reduction in the direct human intervention during the gate operation in turn helps to reduce the collision and accidents at the level cross. Since the gate operations are automated based on the sensors, the time for which the gate is closed is less. Thus, the second objective is automation of the level crossing gates using IR sensors and servo motor.

Even though India possesses one of the largest railway networks in the world, when it comes in terms of the reliability and safety parameters, we have not yet reached truly global standards. One of the main problems about railway safety is crack formation in the structure. Presently, crack detection is done by a gang-man or by hand-pushed or motorised trolleys. Thus the third objective is to make an automatic crack detecting device by the use of LED-LDR technique.

II. LITERATURE SURVEY

A. Power Generation

According to How Stuff Works, piezoelectric materials create a positive and a negative end when work is done to deform their original shape. An electrical charge flows across the material once pressure is relieved from them. While they usually provide very low currents, they can generate extremely high voltages. Harvesting energy from piezoelectric flooring is said to be impractical in residential applications due to the high cost of implementation and small amount of electricity generated in these settings. Common piezoelectric materials include quartz, Rochelle salt, and some ceramics. The New York Times also claims that harvesting energy from piezoelectric materials is inefficient, converting only a small amount of kinetic energy into electricity. The Christian Science Monitor claims that a single footstep could potentially generate enough electricity to power two 60-watt incandescent bulbs for one second, while the International Herald Tribune claims that the technology were implemented in a busy train station that the energy captured could power 6,500 LED lights for an unspecified amount of time.

B. Improvisation of Safety Measures

In the 6 year period between 2009-10 and 2014-15, there were a total of 803 accidents in Indian railways killing 620 people and injuring 1855 people. 9 out of 10 railway accidents during 2009-10 and 2014-15 have been due to derailments and accidents at level crossings. Accidents at the level crossing are mainly caused due to human errors, i.e. if a gatekeeper isn’t alert and doesn’t do the required at the right time. Derailments can be caused due to a variety of reasons such as broken rails, defective wheels, unusual track interactions, etc. The other type of accidents includes collisions, etc. But their number is relatively much lower.

Fig. 1: Improvisation of Safety Measures

| Number of accidents by type in Indian Railways (2009-10 to 2014-15) |
|-----------------|------------------|-----------------|------------------|-----------------|------------------|
| Collisions | 38 | 373 | 340 | 29 | 14 |
| Derailments | | | | | |
| Level Crossing Accidents | | | | | |
| Train accidents | | | | | |
| Misc. accidents | | | | | |
III. DESIGN

A. Power Generation using Piezoelectric Crystals

Fig. 2: Power Generation using Piezoelectric Crystals
In the idea as suggested, we aim at using renewable energy for generating voltage. What we are largely focusing on is installing walking slabs on railway gate crossings. In this way both the vehicle moment when the gate is open as well as the train freight movements while the gate is closed can be smartly used to harvest electricity. Power would be generated by footsteps of crowd on the floor. Piezo plate scheme is located beneath the floor then the then there will be sheet covering the piezo plate and also spring will be there for vibration force on piezo. The piezo plate will be in chunks in the floor. This plate will generate power in the type of electric voltage. The system allows for a platform for placing footsteps. The piezo sensors are mounted below the platform to generate voltage from footsteps. The sensors are placed in such an arrangement so as to generate maximum output voltage. Thus we charge a battery using power from user footsteps. A bridge rectifier is used to provide linearity. The piezos are interconnected in serial and parallel manner.

1) First Prototype
As of for the start we started with 4 piezo crystals of diameter 2.8cm. We got output of around 0.47V. The main reason for such a low output was because we used just 4 piezo crystals, the 4 crystals were placed very far from each other and also the crystals used were of small size. The human pressure was distributed and not fully applied to crystals and that led to a very low output.

Fig. 3: First Prototype

2) Second Prototype
In order to overcome the drawbacks of the first prototype, we designed the second prototype with 20 piezo crystals of diameter 3.5cm, which were placed closed to each other with a placing of 1cm. This prototype gave a output of around 4V. The reason of getting ju's 4V was due to mechanism used to generate human pressure wasn’t very efficient. It didn’t give maximum pressure out of the applied pressure on the crystals.

Fig. 4: Second Prototype

3) Third Prototype
To overcome the drawbacks of the second prototype, we are in the process of making the third prototype. In this prototype we aim at making a better mechanism which will transfer maximum pressure to the piezo crystals and give a voltage of about 30V or even higher.

B. Automatic Level Gate Crossing

Fig. 5: Automatic Level Gate Crossing
The system uses two IR sensors to detect the arrival of the train and a third IR sensor to detect the departure of the train. When the arrival of the train is sensed, signals are provided to the traffic indicating the arrival of the train on the track. When the second sensor detects the train then the signal turns red and the motor operates to close the gate. The gate remains closed until the train completely moves away from the level cross. When the departure of the train is detected by the third sensor, the traffic signal turns green and the motor operates to open the gate. Thus automation of the gate operations at the railway level cross is achieved using sensors.

Fig. 6: Architecture
When IR1 detects the train coming, it sends a high signal to pin 3. As soon as the Arduino UNO detects a high signal, it raises the signal at pin 11 and the components connected to this pin shows an output i.e. the yellow LED glows and the buzzer buzzes. IR2 sends a high signal to pin 5 when the train is detected by it. This sends a high signal to pin 12 and pin 9. Hence, the red LED glows and servo motor rotates 90 degrees. When IR3 senses, it sends a high signal to pin 9 and pin 13. Thus, the green LED glows and the servo motor moves another 90 degrees.

![Circuit Diagram](image)

**Fig. 7: Circuit diagram**

The above shows the circuit diagram of the proposed system. An Arduino UNO is the base of this circuit and all the other components are connected to this board. Three IR Sensors, IR1, IR2 and IR3, are connected to pins 3, 5 and 6 of Arduino UNO. Three LEDs, red, yellow and green, are connected at pin 11, 12 and 13 respectively. Each of these LEDs are grounded through 1kΩ resistor. A servo motor is connected to pin 9. A buzzer is also connected at pin 3.

### C. Crack Detection

In this proposed system, we are using ARM7 controller which consumes low power and also less cost. By using the ARM controller the analysis time of the proposed will be reduced drastically. Before the start of the railway line scan the robot has been programmed to self-calibrate the LED-LDR arrangement. It is necessary because the LDR has a natural tendency to show a drifting effect because of which, its resistance under the same lighting condition may vary with time. After calibration, the robot waits for a predetermined period of time so that the onboard GPS module starts reading the correct geographic coordinate. This is necessary because any GPS module will take some time to synchronize with the satellites. The principle involved in crack detection is the concept of LDR. In the proposed design, the LED will be attached to one side of the rails and the LDR to the opposite side. During normal operation, when there are no cracks, the LED light does not fall on the LDR and hence the LDR resistance is high. Subsequently, when the LED light falls on the LDR, the resistance of the LDR gets reduced and the amount of reduction will be approximately proportional to the intensity of the incident light. As a consequence, when light from the LED deviates from its path due to the presence of a crack or a break, a sudden decrease in the resistance value of the LDR ensues. This change in resistance indicates the presence of a crack or some other similar structural defect in the rails. In order to detect the current location of the device in case of detection of a crack, a GPS receiver whose function is to receive the current latitude and longitude data is used. To communicate the received information, a GSM modem has been utilized. The GSM modem transfers the received information to the GPRS which then shows the exact location of the faulty rail track in the mobile.

### IV. APPLICATIONS

The Piezoelectric installation has many applications. A city in china has adopted this means along its footpaths and a huge amount of energy per day is generated through these. It can also be used in night clubs where in all the foot stomping can effectively be converted into usable power source.

### V. FUTURE ASPECTS

The concept of energy generation using piezoelectric crystals can be further developed to improve efficiency of the voltage per unit area output and can be set up in busy areas. In case of Level crossing, the system can be further modified to an extent where in if a vehicle or a person is stuck in between the 2 gates, the gates to which the vehicle is closest to will open up immediately for the person to exit and get across safely. This can be achieved by using an algorithm of the Internal Positioning system that is the system will predict the path of the vehicle.

### VI. CONCLUSION

We propose a railway system which will use non-exhaustible source of energy, thus bringing down the overall costs of electrical consumption of the railways. Furthermore, level gate crossing automation will require less man power thereby avoiding human error rates.

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### REFERENCES

