

# Advanced Pre-Warning System (Railways)

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**Abstract**—The increased growth in the railway sector has resulted in an increase in the train traffic density across the world. This has resulted in the increase in the number of accidents involving trains. In this paper, the proposed system aims at averting collisions between trains and further it is used to provide the driver with information on obstacles present in the track. The proposed system is an upgrade to the existing TPWS and ACD systems. The system makes use of RFID, FLIR cameras and other embedded systems.

**Index Terms**—RFID, transmitter, receiver.

## I. INTRODUCTION

The Indian Railways has the world's fourth largest railway network in the world, after that of the United States, Russia and China [3]. The railways traverse the length and breadth of the country and carry over 20 million passengers and 2 million tons of freight daily. It is one of the world's largest commercial or utility employers, with more than 1.6 million employees. About 15000 trains work every day. Unfortunately there have been many accidents involved in the railways. Railway bridges may sometimes collapse due to an extended period of service or due to heavy rains, which may make it weak. Derailment occurs when the train leaves its tracks due to various reasons thereby causing instability resulting in accidents [5]. Explosions can also be caused due to terrorist's attacks. When the automated system that controls the train fails, there are bound to be problems. There might be collisions between two trains coming from opposite directions or collisions between other vehicles and the train. This is very devastating and it involves the loss of a large number of lives and property loss.

On an average 10 railway commuters die per day in Mumbai, a total of 4000 deaths per year in Mumbai[5]. Hence it is necessary to provide an advanced protection system.

## II. EXISTING PROTECTION SYSTEMS

The latest protection system used by the Railway System is TPWS. This system provides information on whether two trains are heading towards collision and automatically applies the brake system. But it does not provide any information on whether obstacles are present on the track. These conditions are to be specified in advance to the driver in order to control

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the train.

An Anti-Collision Device is also being used in the Konkan Express. This system makes use of embedded controls and a GPS system thereby preventing collision between trains. However, this system does not take into account factors based on the environment. As a result, accidents due to other factors such as collapsing of bridges or derailment cannot be averted.

The proposed system is designed to overcome the obstacles faced by the TPWS and ACD systems. It is an upgrade to the mentioned systems.

## III. OVERVIEW

The Unit is designed to prevent any accident. The main system or the 'heart' of the Unit performs all the vital tasks of the Unit. As will be discussed in the subsequent sections this system will receive information from the RFID reader, and accordingly transmit the required data via the transmitter to various other units, the system is also responsible for receiving signals from other units and transmitting the data captured in its IR camera to the train. The information transmitted to the train is received on suitable software that gives the train driver an image of what is present at a particular instant in the area under consideration.

The primary purpose of the system is to prevent collision between trains but it also serves to prevent any untoward accidents including natural disasters such as floods, collapsing of bridges, etc or man-made hazards. In other words it is an attempt at improvising the existing TPWS and ACD. In the following sections we will discuss each of the system modules in detail.

## IV. CONSTRUCTION

The construction of the Pre-Warning Unit is as shown in the Fig.1. The working of the various components is explained below.

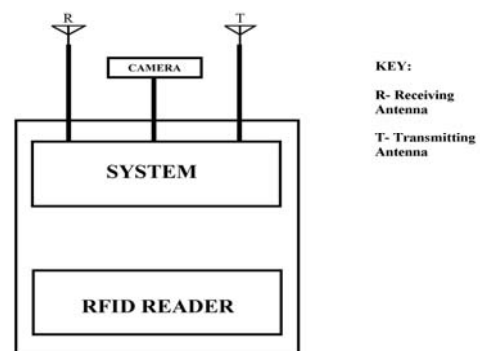


Fig. 1. Main system.

**RFID Reader:**

The RFID reader is fitted with an antenna and a power supply as shown in Fig.2. The power supply is such that the RFID reader can read a RFID tag at a distance of a few hundred meters. Increasing the power supplied to the antenna will increase the distance through which the tag can be read. When an RFID tag is read, a signal is sent to the system for it to work on the next stages of operation.



Fig. 2. Working of RFID in the proposed system.

**FLIR Camera:**

FLIR Cameras are setup on the main unit. They are activated by means of a signal from the system. FLIR Cameras are used to capture images of the track at any instant of time [6]. The captured images are then sent to the system for further processing. The proposed setup is as shown in Fig.3.

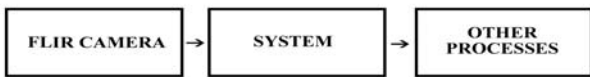


Fig. 3. Working of FLIR in the proposed system.

**Transmitter:**

The main functions of the transmitter are:

- To transmit the signal from one unit to the next two units.
- To transmit the signal from the unit under consideration to the train.

A signal from the system is sent to the transmitter of the unit under consideration. The transmitter then sends the encoded signal from the system to the next two units. When the next two units receive the signal they transmit the images they observe from the unit to the train.

**Receiver:**

At any instant of time there are two receivers under consideration in the setup.

- The receivers of the next two units, which have received the transmitted signal.
- The receiver on the train.

The receivers on the next two units receive the transmitted signal from the Unit that has read the trains RFID tag. The signal in each of the next two units is sent to their respective main systems. This is sent for further processing in the main system.

The receiver on the train is used to receive the transmitted image signal from the two units. This signal is then sent to a system on the train to process and display the image captured from the two units.

**Main System:**

The main system in the unit is used to perform most of the operations. It consists of various components including a Camera Activation Unit, A database containing all the RFID tag numbers, Image Signal Processing Unit and a signal selector unit. This is the heart of the main unit. The circuit diagram of the complete unit is as follows in Fig.4.

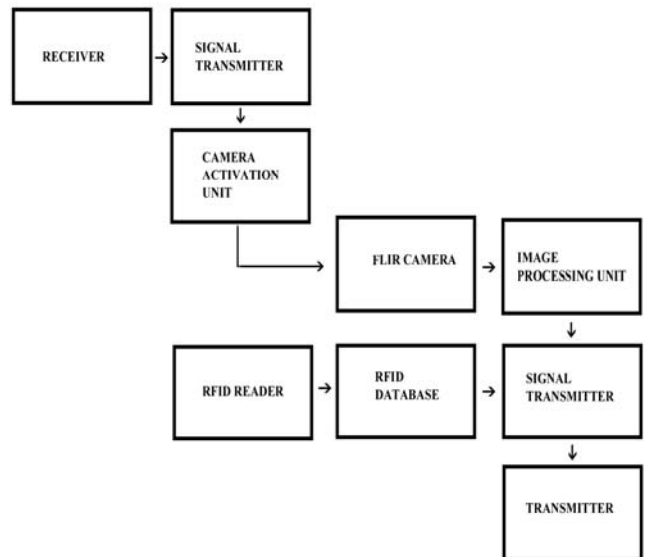


Fig. 4. Proposed system.

**V. WORKING**

To explain the working of the Pre-Warning System, consider three units as shown in Fig.5. Assume a train with an implanted RFID tag passes through the RFID reader [7]. This reader now reads the RFID tag and sends it to the Database, which contains the RFID tag identification numbers of all the other trains. It compares the given tag number with the database. If the tag ID matches with an ID in the application software it sends a signal to a signal generation unit [9]. This unit generates a signal corresponding to the RFID tag and sends it to the transmitter. The signal generator converts the input signal into a form depending on the signals destination. If the RFID reader is activated, the signal from the Signal Generator converts it into a form that the next two Units can receive.

When the signal is received, it is sent to a Camera Activation Unit. This Unit activates the FLIR Camera present. The image captured on the FLIR Camera is sent to an Image Signal Unit. The Image Signal Unit converts the image from the FLIR Camera into an equivalent electrical signal. This signal is sent to a Signal Generator, which converts this signal into a form that the train can receive. This signal is then sent via the transmitter to the train.

The train's receiver, on receiving the signals from the two units sends it to the application software present on the train. The train driver can interpret the received image on the screen for further functioning of the train. In case the track is broken or the area is flooded or if another train is arriving on the same track, the driver can take appropriate measures and protect the passengers on the train.

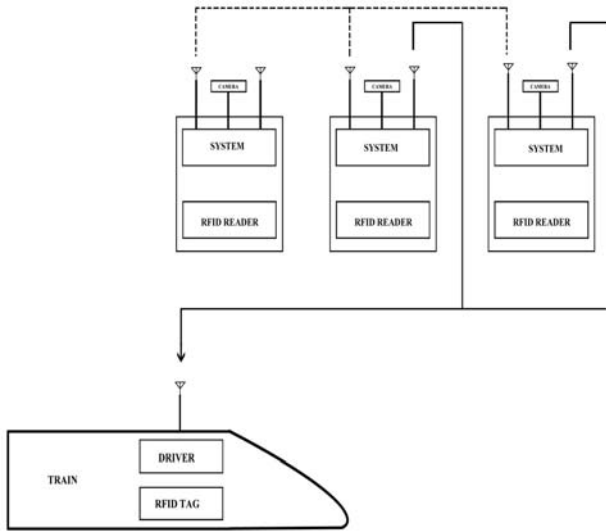


Fig. 5. Real time application.

Let  $f(t_1)$  be the transmitted signal from the UNIT II

Let  $g(t_2)$  be the transmitted signal from UNIT III

The signal received by the receiving antenna on the train is given by

$$R(t) = \text{function}(f(t_1), g(t_2))$$

where  $R(t)$  is the signal received on the train

## VI. CONSTRAINTS AND RESEARCH WORK

The main constraint on the system lies in the generation of power of the RFID system. The RFID reader is capable of reading tags at large distances by making use of more power [1]. This constraint can be overcome by making use of renewable sources of energy, which may reduce the cost of power generation. Further, the cost involved in setting up the system is expensive as the power generated is directly proportional to the cost. The setting up cost cannot be reduced until further research is undertaken. However, on a long-term basis this system is feasible. Concerns regarding the security of the RFID tag can be overcome using the method of encryption proposed by Heung-Kuk Jo and Hoon-Jae Lee [8].

## VII. CONCLUSION

In this paper, a system to avert train collisions and accidents due to the environment is proposed. The proposed system is a part of an upgrade to the Anti-Collision Device and the TPWS used in the railways. Hence the proposed system is found to be a promising method in Train protection. It can further be used on various other vehicles for protection.

Appendix

RFID- Radio Frequency Identification

TPWS- Train Protection Warning System

ACD- Anti Collision Devices

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