

## An Inventive and Innovative Alternate for Legacy Chain Pulling System through Internet of Things

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### Abstract

*Indian Railways made a move in replacing the chain pulling system with the new mobile based communication system where the loco pilot's mobile phone number shall be shared with all the passengers through a message. Despite the efforts taken to remove the chains from the train, there is a great probability of misuse through the mobile phone number provided. We aim to build a more efficient and secure solution based on the Internet of Things, which is a buzz word in the market. Our proposed system provides an alarm fixed at specific locations in the compartments of a train. In case of emergency, the passenger has to press the alarms' button, which captures the scene using a built-in digital camera. The system also alarms the Loco-Pilot, Travelling Ticket Examiner, as well as the compartment so as to provide immediate possible help through the fellow co-passengers. The pilot slows down the train to an optimum speed whilst the travelling ticket examiner checks and confirms the pilot whether he has to stop the train. The entire system can be controlled through an authenticated mobile application provided to the ticket examiner. The pictures captured by the camera and other crucial details are uploaded to a cloud-based real-time database. Thus, saving time and taxpayers' money as well as helping the railways to perform analytics and come up with feasible solutions to the problems of the passengers. The system has the potential to deal with the most prevailing cargo theft like that of coal, by alerting the staff without having to stop the train, making the convicts' escapes impossible. This also definitely avoids the improper pulling of chains and thereby not causing any hassle to the passengers as well as diminishes the economic loss to the government by reducing the time delay.*

**Keywords:** train chain pulling, cloud storage, emergency stopping, Indian railways, internet of things, passenger comfort, coal theft

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### 1. Introduction

As a part of the great Digital India campaign initiated by Honourable Prime Minister of India, Indian Railways is extending its digital capabilities to deal with numerous challenges in the network's daily routine [1]. One can call it loud that the Indian Railways is undergoing a definite transition towards its betterment, digitally. With similar intention, this paper proposes a solution to one such important problem, the emergency train stopping system. The trends in computing and internet of things made this possible, feasible and viable. This is one of the most prevailing problems pertaining the Indian Railways and is also the main reason for the train delays in many parts the country. The railways updated the old chain pulling system with a mobile-based service that renders the mobile phone numbers of the loco pilots to the passengers through an SMS before the start of the train [2]. This is not only a distraction to the loco pilot but also raises a chance for miss utilization of the service, which includes prank calling loco pilot after leaving the train. The lack of network coverage along the train routes adds more challenge to the existing loopholes. Above all these, someone may not want to carry a phone or may not have a phone. India is yet to get used to this method and problems faced in this system are to be reported, yet. One would probably have a hand full of problems or challenges in this approach.

So, the challenge before us is to validate the emergency stop request and take care that the cause to halt the train is unharmed. To put it short and sweet, we are trying to automate the process while not compromising the security and authenticity.

### 1.1. State of the Art- An Analysis of the Existing System

The proposal is made with an intention to provide a better service to railway passengers, efficiently handling emergency scenarios and reducing the economic loss that is incurred due to the unnecessary halting of the train [3]. To achieve this, we plan to establish a secure medium for the train authorities to monitor and communicate with the on-board passengers, hence helping them to take right decisions during critical situations. This not only reduces the loco pilot's burden but also eliminates the misutilization of loco pilots' mobile phone number, which is given in public interest. As our system's network is completely locale to the train, the challenge with network connectivity does not arise. Thus, we suggest and provide a stable, reliable and secure system to the railways to carry on its routine without hassle while also considering the economic viability.

## 2. Related Work

### 2.1. Insights into the Working of Chain Pulling System

It has been a long time since the Indian Railways introduced the chain pulling system in the trains. As the years passed, the need for public transportation increased. To meet the requirements, the railway network along with the number of trains has been dramatically increased. But, the chain pulling mechanism is the only emergency braking system serving the passengers since then.

The chain pulling mechanism is entirely mechanical; its schematic representation as shown in Figure 1. The two pipe hoses between every two coaches are for the continual connection of the train compartments. The alarm valve vent as shown in Figure 2, which plays a major part in chain pulling system, locks the air from entering the braking system when the chain is pulled. This will initiate a sudden drop in air pressure, hence triggering the brakes [4].

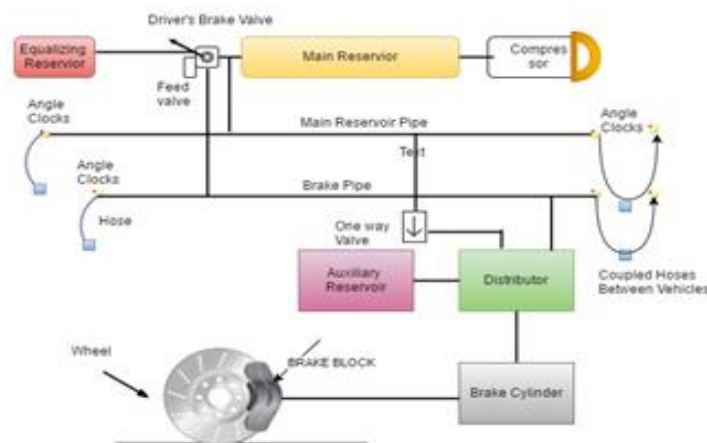


Figure 1. Schematic Diagram of the braking system

In a moving train's point of view, once the chain is pulled, its associated warning bulb as shown in Figure 2 is triggered and the train's is slowed down by a rapid drop in power. The guard at the end of the train can also notice a loss in the brake pressure with the help of a gauge and uses his brakes to help stabilise the train. It is obvious that guard may not be sure about the reason for the loss in air pressure. The loco pilot also gets the information about the air pressure drop and he ensures smooth stopping of the train by his technical skills. The loco pilot has the authority to override an emergency stop request by superseding the alarm chain pull [5]. These cases are very rare and usually take place in an abrupt stopping of trains or derailling. Usually, the loco pilot gets the information first and notify the TTE and the guard by whistling in a two short one long manner. It is pretty much evident from the above complexities that stopping a train is not an easy job and giving unrestricted access to the brakes to all the passengers is something to give a thought to.

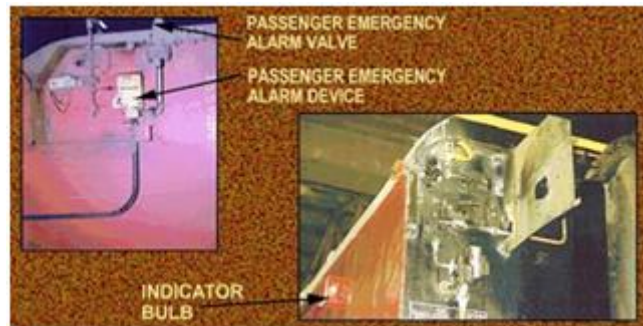


Figure 2. Passenger emergency alarm valve, Sandip Besra, Railmaniac, Web. 21 Mar 2017

## 2.2. Major Drawbacks of the Chain Pulling System

Once the train stops, the guard and onboard crew have to find the compartment with the indicator bulb switched on. This is the compartment where the chain is pulled. The crew has to release a small lever at the brake valve at the end of the coach as shown in Figure 3. This whole process has to be done manually as the lever does not come back to its initial position even after the chain is released. Alarm and bulb associated will remain active until the lever is reset [6]. Adding to this the lamps and alarms are controlled by a circuit breaker which has to be taken care of as well. This is one of the main reasons for the huge time delays after a train is halted due to emergency stop [7]. This is not required when the train is generally stopped by the loco pilot. Hence a huge amount of time, thus money can be saved by making the passengers signal the loco pilot rather than allowing them to stop the train themselves.



Figure 3. Passenger emergency alarm signal device, Sandip Besra, Railmaniac, Web. 21 Mar 2017

Hence this system needs a lot of manual intervention say, from the guard, TTE and loco pilots. There is no scope to check the validity of the emergency stop request, which really is the root cause of all the challenges. Miss-utilization this provision, many passengers indirectly incur huge economic and labour loss. To overcome these complications, the Indian Railways have come up with a new system where the passengers will be provided with the mobile phone number of the loco pilot and are allowed to contact him in the case of emergencies. The vulnerabilities in this new system include the lack of mobile network connectivity in most of the rail routes and every passenger is expected to possess a mobile all the time. Above all the system's scheme adds a lot of work to the already hefty job of the loco pilot. The purview of the misuse is vast and even includes youngsters try to prank the driver. Analogous to the chain pulling system, there are a lot of loopholes that should be paid attention to. Hence, the change in the system did not bring in as many solutions required.

Some of the serious challenges Indian Railways are still facing are as follows. The huge risks of derailing accidents increase when someone tries to stop the train when it is at high speeds. The sudden drop in speed can cause the train to become unstable. The loco pilot has to put in all his experience and skills to handle the situation from worsening or to prevent the train from derailing at curvatures [8]. Studies have shown that these chain pulling related accidents have been very adverse always and even the punishments and penalty introduced by the government has not reduced it anyway.

Another challenge before the railways is the huge goods loss especially that of coal [9]. This is mostly observed in rural north India. Locals in the areas in Jharkhand have been reported for coal theft for years together. Coal robbery is a way of life for those people. Reports show an estimated 600 crore rupees annual loss due to coal theft in the state of Jharkhand alone [10]. Trains are usually stopped in the middle of jungles and very remote areas and coal units are looted [11]. As anybody can stop a moving train in the middle of nowhere, where the train is vulnerable, it does not take much courage for people to turn into robbers. Though not everyone will attempt to steal, it is enough if even very few turn robbers.

### 3. Architecture of the Proposed System

To construct the proposed system we make use of interconnected computing units, one can call it IoT (Internet of Things) [12]. They do the talking to the sensors and actuators of the system. The system includes emergency stop buttons, which alarms the crew as well as the co-passengers in that particular compartment. A camera is installed to capture an image of the person who triggered the alarm which, not only serves as a reference for TTE to identify but also, as a proof for further official proceedings with the appropriate court of law. The proofs along with other crucial data are then uploaded to cloud servers when the train goes through stations with Wi-Fi capabilities. The entire system as shown in Figure 4 can be controlled by an authenticated android application which is to be possessed by the TTE. The cloud resources can be accessed from anywhere by the railways.



Figure 4. Proposed implementation strategy

### 4. Functioning of the Proposed System

The proposed system comprises of three major units. First being the input, second being the control unit and third being the storage unit. All the units coordinate and make the infallible workflow possible. The brief explanation of each unit is as follows (Figure 5).

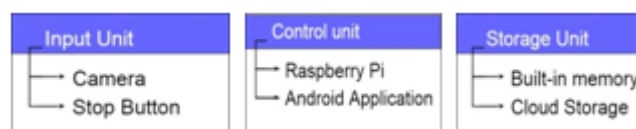


Figure 5. Core units of the system

#### 4.1 Input Unit

The stop button, camera and the alarm are controlled by the computing device as shown in Figure 6, which is supervised by on-board staff using an android application. The application is authenticated to ensure security. All the devices mentioned above are powered by the computing device itself, which in turn, draws power from the train. The embedded system and all the peripherals connected to it consume very low power.

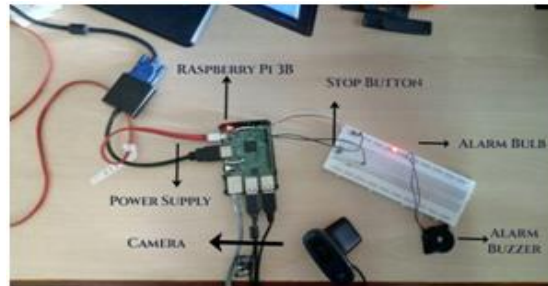


Figure 6. Prototype of the proposed system

The Raspberry Pi 3, which is the computing system of our board, is powered by a +5.1V micro USB supply channel as portrayed in Figure 7. We have found that a 2.5A power supply will provide ample power to run the system. This small amount of power can be easily taken from the surplus power of the train.

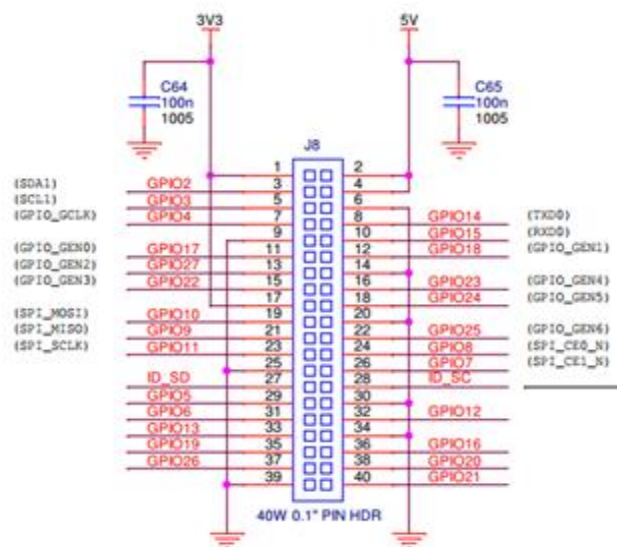


Figure 7. Schematics of Raspberry Pi 3 B GPIO Schematics - *Raspberry Pi Documentation*.  
Raspberrypi.org. N.p., 2017. Web. 21 Mar. 2017.

#### 4.2 Control Unit

This core unit comprises of multiple Raspberry Pis, which are a single board computers. They are pre-programmed and are interconnected among themselves as well as with the authenticated devices the TTEs carry. The devices use an android application that lets the Raspberry Pi to share control and information with the TTE through a secured channel. The information includes the pictures of the passenger like in the Figure 8, who triggered the alarm along with other vital information retrieved from the system's sensors.





Figure 8. Sample picture captured from the camera module

#### 4.3 Storage Unit

All the collected resources are primarily stored in the computing devices' internal memory. The viable data from the sensors and the data collected by the TTE after any valid case are tagged and stored. Such crucial information is then uploaded to cloud storage when goes through railway stations with Wi-Fi capabilities. Thankfully the Indian Railways have provided Wi-Fi facility in most of the busy railway stations [13]. Hence, facilitating the authorities to perform analytics and come up with feasible solutions to the problems of the passengers.

#### 5. Application Workflow

For the effective functioning of the proposed system, the crew and the passengers should follow the below mentioned protocol.

In the case of emergency, the passenger has to press the alarms' button, which captures the scene using a built-in digital camera. The system then alarms the Loco pilot and the TTE as well as the compartment so as to provide immediate help possible through the fellow co-passengers. Meanwhile, the loco pilot has to slow down the train to an optimum speed whilst the TTE checks and confirms the loco pilot whether he has to stop the train. The entire system is controlled through an authenticated mobile application provided to the TTE. The pictures captured by the camera and other crucial details are uploaded to a cloud-based real-time database as depicted in the Figure 9 [14].

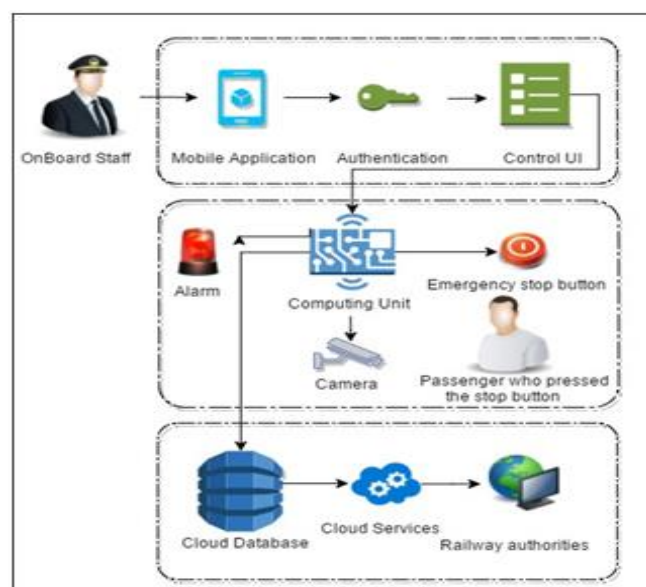


Figure 9. Proposed workflow

## 6. Vast Scope for Advancements

There is a lot of scope to improve its working, and can make the product cheaper, compact and durable. More smartness can be brought in with rapidly growing IOT technologies. The same can be made mandatory in all trains in India, ensuring to provide the best care to all the citizens. Centralised data monitoring and analytics can be carried out to identify patterns and work upon it to improvise the network. Also, better image processing algorithms can be used towards identification and retrieval for the human faces [15, 16].

## 7. Conclusion

This system comprising of Raspberry Pi, its peripherals and an android application, provides a secure and efficient emergency stopping procedure. This helps the railway staff to have better control during emergencies. As this is simple and inexpensive this can be immediately implemented in the regions where the chain pulling cases are the highest. Hence through this approach we could prevent wastage of both railways and taxpayers' time and money.

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