Design and Development of Elephant Repellent System with Automated Train Barricade for Sri Lanka

Eng.S.Jeyaram[a], Eng.M.P.M.Suhail[b], Mr.S.H.Samarasinghe*

[a] jeyarams@esn.ac.lk
[a]Eastern University, Sri Lanka, Nilaveli, Trincomalee, 31010, Sri Lanka
[b]suhailmpm@esn.ac.lk, Eastern University, Sri Lanka, Nilaveli, Trincomalee, 31010, Sri Lanka

Abstract

Railway system is one of the most efficient transport medium in the world. In Sri Lanka, most of the people use railway system for their day to day transportation. There are two major safety issues faced by Sri Lankan railway network, those are human – train collision due to negligent behavior of pedestrians and drivers, and elephant – train collision which comes under the Human-Elephant Conflict (HEC) due to failure processes of the early warning systems, bio fencing, thermal cameras, etc. The Sri Lankan elephant (Elephas maximus maximus) is an endangered subspecies. Some of the researchers have provided some solutions for this matter. But any of these solutions could not be practiced successfully in Sri Lanka. This is the motivation for this research. The scope of the research project is design and implement more effective and practical solution for preventing human-trail and elephant-train conflicts. The methodology of the project consists of three systems; system connected to the train, automated train barricade system, and elephant repellent system which separated from each other but connecting via radio signal in some special cases using Arduino technology. The results from our preliminary study and test results show that any elephant wandering near the incoming train got repelled by our system.

Keywords: Human-Elephant Conflict (HEC); Sri Lanka; Arduino; Microcontroller; Infrasound Elephant Repellent

1. Introduction

In Sri Lanka, railway system is one of the major transportation systems spreads throughout the country. It was introduced by the British colonial government in 1864 in Sri Lanka, mainly to transport tea and coffee from the hill country to Colombo. Extensions were made to the main line in 1867 up to 1928. For more than 80 years after that, no major extensions were added to the Ceylon railway network. The poorly maintained system is causing sever death penalties to humans and wild elephants. It leads to the much-debated issue in Sri Lanka that is Human-Elephant Conflict (HEC).

The railway tracks in Sri Lanka are divided into Coast/Matara, Kalayani valley, Kandy, Talai Mannar, Northern/Jaffna, Mattale, Badulla, Mihintale, Batticaloa, Balliata, Trincomalee, Puttam, Arukkawil [1]. Sri Lanka Railway operates approximately 396 trains which include 67 Long-Distance and 16 intercity trains and

carries about 3.72 Million passengers daily [2]. Most of the train-elephant collisions occur on the Northern/Jaffna, Trincomalee, Batticaloa and Talai Mannar railway line and a few on the Puttlam railway line. Accident prone railway sections covering different time period is shown in the Fig. 1. [1].
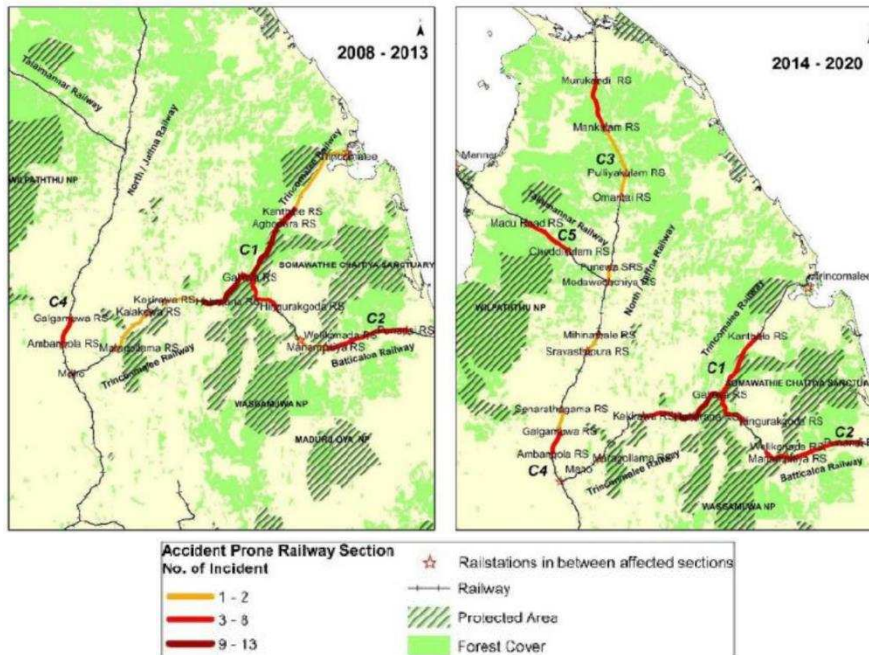

Fig. 1. Elephant – Train Accident Prone Areas in Sri Lanka

Approximately, between 2005 and 2018, about 122 elephant deaths resulting from train collisions were reported in Sri Lanka [3].

Sri Lankan government took lot of HEC prevention projects in railway such as Underground crossings, overhead bridges for elephants, Electronic system that piloted on the Mannar railway line near Settikulam area [4]. The already installed electronic system triggers the train operator and control room in the presence of wild elephant. So there is a gap in repelling the elephant effectively.

The main scopes of this research project is filling that gap, also safeguarding human beings with the automated railway barricade.

2. Research Elaboration

The main scopes of this project is repelling the elephants effectively and trigger the operator, and automated train barricade to safeguard human beings from human negligence and manmade errors. The system consists of Elephant Repellant System, Train Transmitter, and Automated Train Barricade

2.1 Elephant Repellant System

Infrasound is the key idea to repel the elephants. This system is made with Arduino Nano microcontroller board, NRF24L01+ wireless transceiver module, and Active buzzer which are powered by solar panel.

This repellent sound system need to be placed in the more prone area of elephants in the railway network. When the train enters to the range of 2 Km circle of this system, the transmitted signal from the train will activate this device to trigger the repellant sound with the frequency of 1450 Hz. The system will be disengaged when the train leaves from the range.

2.2 Train Transmitter

Transmitter system is designed with Arduino Nano microcontroller board with NRF24L01+ wireless transceiver module. It need to be installed in all the train travels in the prone area. The transmitter activates the elephant replant system when it reaches within the 2 km range of the elephant replant system. The used wireless systems is working in the 2.4 GHz band and it can operate with baud rates from 250 kbps up to 2 Mbps. The transmitter range can be extended with the low baud rate and separate antenna module.

The system is powered from the train engine and transmitting data continuously. The transmitter can also be manually turned on and off.

2.3 Automated Train Barricade

This system need to be integrated with the existing railway crossing gates. System is made up of Arduino Uno board, NRF24L01+ module, servo motor, TM1637 display module, and Ultrasonic sensor. The system is powered by solar panel. When train reaches nearly 2 Km in radius, the system picks the transmitted signal from the train. In the presence of incoming train, the system will display "STOP" message with blinking, then start the countdown timer of 10 seconds. Once the timer reaches zero, it automatically closes the railway gate.

That ultrasonic sensor on the system monitors the train status and any intervention of humans. System will be automatically restarted when train passes the specific rage from the railway gate system.

3. Results

The main scopes of this project is repelling the elephants effectively and trigger the operator, and automated train barricade to safeguard human beings from human negligence and manmade errors. The system consists of Elephant Repellant System, Train Transmitter, and Automated Train Barricade.

The automated train barricade system was integrated with the railway crossing gate. It upgraded the existing manual system with automation and smart display system.

When the train reaches to the range, digital display shows 'STOP' message, and closed the gate after 10 seconds of countdown. The inbuilt ultrasonic sensor monitors the human behavior and the status of train. The system will automatically reset when the train leaves the 2 Km range.

The summary of the results are as follows:
• In the presence of train within the range of 2 km, the elephant repellant system got activated. It repelled the elephants using infrasound.
• In the presence of train within the range of 2 km, the automated barricade got activated. It safely closed the railway gate with smart display.
• The ultrasonic sensor in the automated barricade system monitors the human presence and the status of the trains passing, to increase the safety operation of the system.

4. Conclusion

The best places for implementing this system is identified, and the system achieved the following objectives; Repelling elephants for the incoming train, and the railway gate is operated automatically for the arrival of train.

It is the most effective and practical solution for HEC in Sri Lanka. The major issue of the system is, the repellent system can be damaged by elephant or stolen by some people. The system is designed with Arduino microcontrollers, sensors, and actuators which are not rugged. Modern technologies like IoT and Artificial Intelligent can also be adopted to the system to improve its efficiency and features.

Researches from General Sir John Kotelawala Defence University are on the way of developing HEC reduction system using Machine Learning (ML) [5].

5. Acknowledgment

6. References

[1] Mukti Roy, S Ajanikar, S Chatterjee. (Sep. 2022). 18th International Elephant Conservation and Research Symposium. "Assessment of Train elephant Collisions in Sri Lanka". Available: https://www.researchgate.net/publication/363290968_Assessment_of_Train_elephant_Collisions_in_Sri_Lanka

[2] Sören Köpke, et al. (Aug. 2021). Sustainability 2021 - MDPI, Basel, Switzerland. "Human - Elephant Conflict in Sri Lanka: A Critical Review of Causal Explanations". Available: https://pdfs.semanticscholar.org/0bc7/3d87c2d90ced17e8382bc380f0408e9f7f91.pdf

[3] Rob Ament, et al. "Protecting Asian Elephants from Linear Transport Infrastructure", Asian Elephant Transport Working Group, Bozeman, USA, 2021, Available: https://www.asesg.org/PDFfiles/Protecting.pdf

[4] Charunya Rajakaruna, 20th of September 2018, "Sri Lanka to implement measures to prevent elephant-train collisions", Available: http://www.adaderana.lk/news/50152/sri-lanka-to-implement-measures-to-prevent-elephant-train-collisions

[5] CT Wijewantha, WPJ Premarathne, and WMKS Ilmini. (2019). 12th International Research Conference 2019, KDU. "Reducing Frequent Killing of Elephants from train collisions using Machine Learning". Available: http://ir.kdu.ac.lk/bitstream/handle/345/2280/com029.pdf?sequence=3&isAllowed=y

[6] Missaka P. B. Wijayagunawardane, Roger V. Short, Thusith S. Samarakone, K. B. Madhuka Nishany, Helena Harrington, B. V. P. Perera, Roger Rassool, Evan P. Bittner. (2016) - The Use of Audio Playback to Deter Crop-Raiding Asian Elephants. (Wildlife Society Bulletin; DOI: 10.1002/wsb.652)

[7] Medha De Alwis. (2019). Elephant-railway conflict. Available at: https://www.themorning.lk/elephant-railway-conflict/

[8] Sri Lanka Wildlife Conservation Society. (2018). Elephants Are Being Killed By Trains. This Organization Has A Plan To Stop It. Available at: https://www.movinggiants.org/blog/elephants-are-being-killed-by-trains