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A conceptual model to detect seat damages in train compartments

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ABSTRACT

Railway transport is one of the most popular public transportation mechanisms, which serves about seven million passengers daily. The Department of Railways has provided various provisions and safety regulations to provide its passengers with a superior and convenient service. However, some irresponsible passengers are not following the rules and regulations imposed by the department and damaging the various parts of the train compartments. Unscrupulous damage and writing junk on the seat are significant issues. There is no proper mechanism to identify the passenger who damages the train seat. Currently, the Department of Railways tries to control these problems by finding and controlling them by using their employees as inspectors, but it is not up to their expectations. This study aimed to address the problems related to seat damages by using the images retrieved from train compartment cameras, which are permanently fixed inside train carriages. The system will identify the damage done by a passenger to the train seat by comparing the seat images at regular time intervals using image processing techniques and Convolutional Neural Networks. When there are damages, the department staff will be notified with the proof of damages and passenger information. A pilot project is under development for long-distance first-class train compartments. The proposed model has currently achieved over 94% training accuracy while identifying damages to the seats. The proposed model will be further enhanced to identify all kinds of damages to the train compartments across all classes in the train. The improved model will help the railway department protect its train compartments while providing an enhanced experience to its passengers.

Keywords: Damage detection system; Train seat damages, Unscrupulous junking on seat.

INTRODUCTION

Sri Lanka is a third-world country that people face many challenges in day-to-day life. One of the main challenges that the public face is the transportation problem. During the morning and evening rush hours, roads are filled with vehicles, and in areas like Colombo, it takes about an hour to travel few kilometres. This led to the extra wastage of fuel, time, and money of the public. As a solution for this problem, many people are used to travelling by train because trains travel faster in the rush hours compared to the other land transport methods like buses, taxies and the train ticket cost almost the same as a bus ticket. Figure 1 shows the number of trains travelling per day, and the number of passengers travels per day (Sri Lanka Railways 2021). As a country, we do not have a widespread railway network. Costing a massive amount of money to create new train routes may be the reason for that. Even maintaining the existing infrastructure cost a lot to the government. Therefore, we should focus on protecting the railway resources that we have. In achieving the above objective, there are problems involved with protecting the trains. Some irresponsible passengers are not following the rules and regulations imposed by the Department of Railways, Sri Lanka. They damage the various parts of the train compartments and seats. It was observed that damaging and writing junk on the seat are the major issues. Among these various problems, this research focuses on one major issue and tries to minimize that issue. This research aims to detect the train seat damages and take necessary actions to prevent passengers from damaging public properties. The Convolutional Neural Network (Dung and Anh, 2019) was used, and the proposed system detects the damages in the train seats. As mentioned earlier, passengers damage the various parts of the train compartments and seats. It was observed that damaging and writing junk on the seat are significant issues. Moreover, it was identified that there is no proper mechanism to identify the passenger who damages the train seat. Currently, railway department tries to control these problems by finding and controlling them by using their employees, but it is not practical up to their expectations. As a result of that, the department is facing many problems such as maintaining the carriages, and they have to spend a lot of time, money and resources to repair the damages to the train seats. Passengers do these activities intentionally or unintentionally. Either way, the cost for these damages is high, and it cost a lot to repair these, and indeed the passenger ticket money will not cover the cost. Considering the above facts, it is evident that there should be a way to identify the damages and the responsible passengers for the damages. Furthermore, the trains in Sri Lanka are more than a day-to-day transport medium. The railroad, like upcountry railroads, is the major tourist attraction of the country. Some foreigners especially come to Sri Lanka to travel on upcountry railways. These trains should be adequately maintained to keep the attraction the same way and give the tourists a good experience. Therefore, as mentioned above, it is essential to identify passengers who are damaging the facilities of the train in order to achieve the desired objectives. However, the problem arises when identifying these passengers. So, the research problem of this research is to find an effective way to identify the passengers who harm and damage the

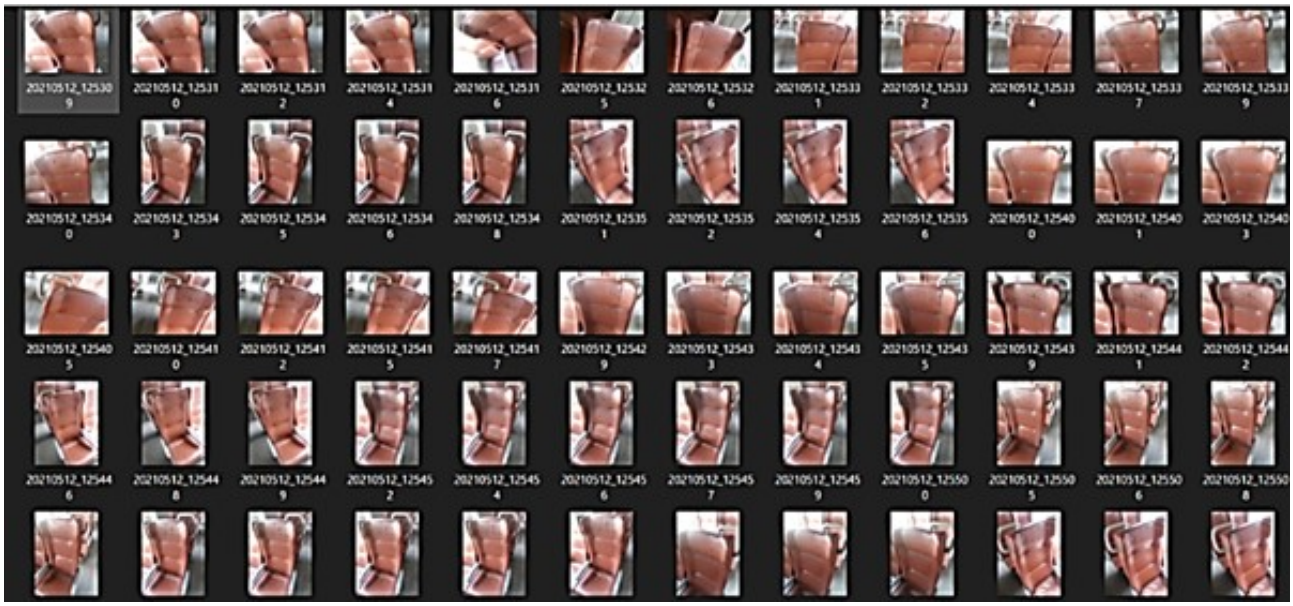

Figure 1: Dataset

train. The objectives of the research were (1) to identify the train seat damaged, (2) to recognize faces of persons who damage to train seats, (3) to shift towards a better railway transportation system in Sri Lanka.

METHODOLOGY

This research paper focuses entirely on identifying train seat damages and preventing damage to public transportation methods by identifying people prone to unwanted activity. Many steps have been taken to move this research to its final output. Problem identification, data gathering, data analysis, find the best platform and technologies for the model development, set up the platform and technologies, data preprocessing, create a model, train the created model, evaluating and show outputs are the steps taken to achieve the end goal. There are 1193 images used for this research as the dataset. As undamaged train seats, there are 762 images, and those images contain the current appearance of the train seat. There are 431 images used as damaged seat images. About 70% of the data used as a training dataset, 20% of the data used as validation data and 10% data used as a test from the dataset. It is expected to take the undamaged images of the train as soon as a new train is added to run.

There are cameras in the train to take pictures of the train seats. Those images are images of seats with and without damages. This research is aimed at comparing train seats based on seat headrests/armrests. Figure 2 shows that most people use to damaging the headrests rather than the backrest and seat. Therefore, it will be easy to detect the changes even the passenger is seated. The proposed system also captures images of passengers. There, passengers do not have to worry about photographs taken by the Department of Railways, as Sri Lanka exercises it. Therefore, it is hoped that taking and keeping passenger images under the control of the government is not a violation of ethical rules. For example, some buses of Sri Lanka Transport Board capture CCTV footage of their passengers to use in the event of an incident.

Figure 2: Damaged seat

The proposed solution is a system that uses the Convolutional Neural Network (CNN) to find damaged seats. Before training, the model was trained using undamaged seats. Using CNN (Mohan, 2018), the detected train seat images will be compared with the undamaged train seat images. Captured train seat images were preprocessed into Grayscale before comparison. If there are any changes, the system will return the result, whether it is damaged or not. Figure 3 show the Convolutional Neural Network.

As explained earlier, the system captures the images of train seats and the compartments. Those images will be captured using the train compartment camera mounted on the compartment's roof, and captured images automatically save in the testing data folder. The dataset of

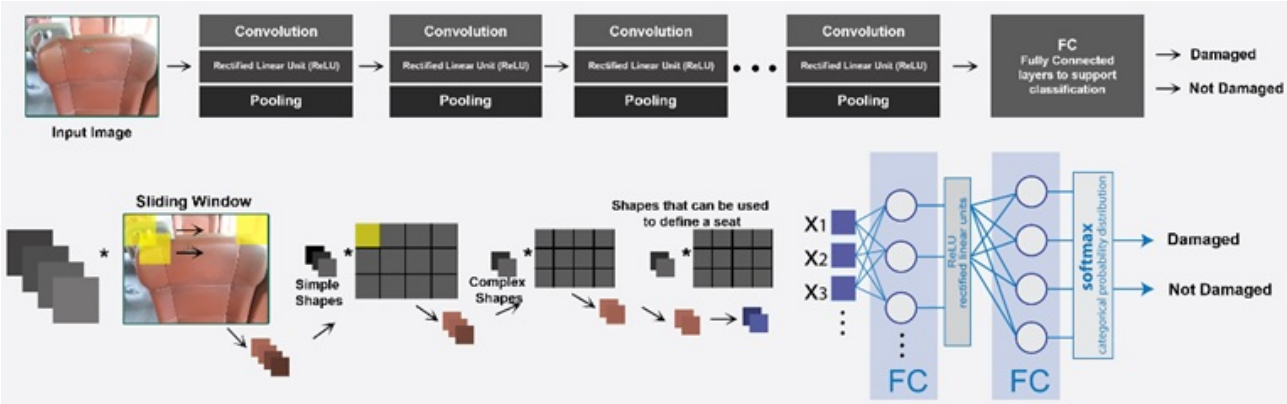

Figure 3: Convolutional Neural Network

this model is divided into three main categories as training, validation, and testing. Once the dataset is completed, it will be analyzed and pre-processed to remove duplicated empty and unnecessary images. All image widths and heights are resized to 224 x 224 (Hashemi, 2019). Each image will be resized by scaling the image. Then the model will cluster the image to identify whether the train seat image belongs to non-damaged or damaged clusters. Finally, it suggests the output. The damaged seat and the compartment can be identified by the following method discussed in this paper. When the railway department installs the cameras, they record which camera is installed in which compartment. The camera is mounted in the middle of the compartment's roof, so it is easy to locate the damaged seat at a distance from the camera.

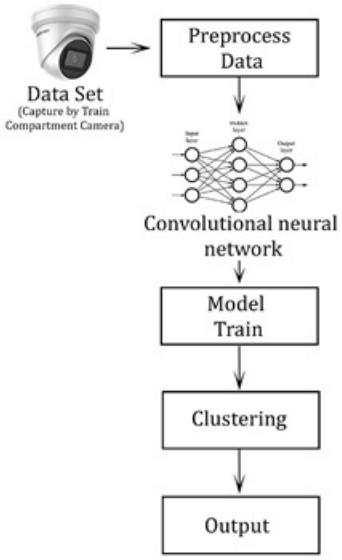

Figure 4: System architecture

Furthermore, they may mark each seat with a number format. Therefore, these ways will help to identify the damaged seats quickly. The diagram in figure 4 shows the system architecture of the methodology, and figure 5 shows the flow diagram of the methodology. which explains this proposed model step by step.

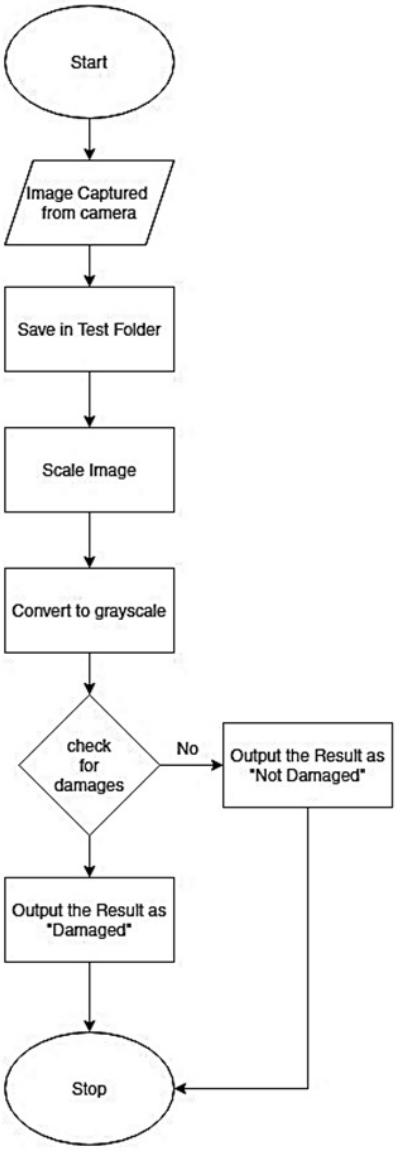

Figure 5: Flow diagram

Table 1: Results of model performance

Epoch	Loss	Accuracy	Validation loss	Validation accuracy
1/10	0.9388	0.6337	16.1421	0.4804
2/10	0.4200	0.7670	7.9418	0.4804
3/10	0.3558	0.8928	5.4375	0.4804
4/10	0.2453	0.8910	4.9381	0.4510
5/10	0.1873	0.9162	4.4400	0.4216
6/10	0.1398	0.9489	2.1554	0.5294
7/10	0.1486	0.9430	1.9631	0.5490
8/10	0.1539	0.9296	2.4696	0.4265
9/10	0.0891	0.9715	2.8054	0.5294
10/10	0.0621	0.9424	2.6100	0.4657

In this model, accuracy is the fraction of predictions the model got right. Formally, accuracy has the following definition:

$$\text{Accuracy} = \frac{\text{Number of correct predictions}}{\text{Total number of predictions}}$$

The loss is the sum of errors made for each example in training or validation sets. Loss value implies how poorly or well a model behaves after each iteration of optimization. Moreover, it is assumed that using 10 as an epoch would be better for the model, and this model has a good level of accuracy with 10 epochs. Table 1 shows the model performance of the proposed conceptual model.

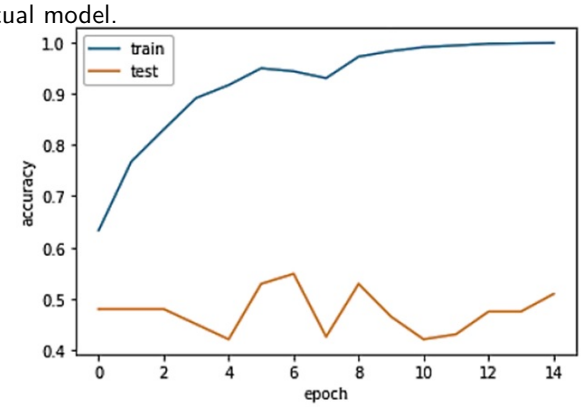

Figure 6: Model accuracy graphs

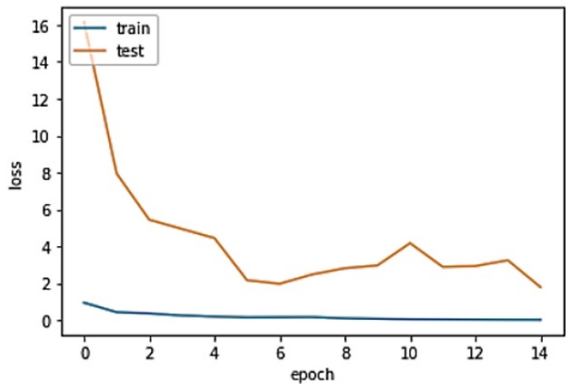

Figure 7: Model Loss Graphs

RESULTS AND DISCUSSION

As explained earlier, there are 1193 images used for this research as the dataset. As undamaged train seats, there are 762 images, and those images contain the current appearance of the train seat. There are 431 images used as damaged seat images. Identifying damaged seats in train compartments and sending the notification to the relevant officers in the railway department is the primary objective of this research. The developed model suggested the accuracy and losses of 94% and 11.6%, respectively. Figure 6 shows the accuracy graph of the proposed conceptual model, and Figure 7 shows the loss graph of the proposed conceptual model.

CONCLUSION

This paper presents a conceptual model; it is believed that this model will be integrated into the existing railway management system to facilitate the Department of Railways to minimize the management loss to the compartments by reducing the expected cost of carriage maintenance and to identify irresponsible passengers who are damaging the railway locomotives. At present, the model shows good accuracy, and the model will be further developed by taking various other inputs.

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