INTELLIGENT CROWD MANAGEMENT SYSTEM IN TRAINS

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Abstract— The advent of mass transit systems like rail, metro, maglev, and various other rail based transport has pacified the requirement of public transport for the masses to a great extent. However, the abatement of the demand does not necessarily mean it is managed efficiently, eloquently or in an encapsulating manner. The primary problem identified; the one this paper seeks to solve is the dipsomaniac like manner in which the compartments are occupied. This problem is solved by using a comparison of an empty train and an occupied one. The pixel data of an occupied train is compared to the pixel data of an empty train. This is done using canny edge detection technique. After comparison it intimates the passengers at the consecutive stops which compartments are not occupied or have low occupancy. Thus, redirecting them and preventing overcrowding.

I. INTRODUCTION

The recent accretion of the mass transit systems due to several reasons such as travelling at convenience, avoiding traffic during peak hours as well as being cost efficient. Though due to the hike in the usage of this transport there is a problem in the inefficient accommodation of the passengers travelling due to the lack of time to get into the compartment which is empty. This paper is aimed at solving the problem of crowd management in order to cater to the needs of the passengers that travel at inconvenience sometimes. Certain modern metro coaches have the facility to change the compartments while it is in motion, but more of the coaches do not permit this. A situation or scenario is considered where the number of people present inside the train and the number of people waiting to board the train should be managed effectively in order to avoid overcrowding. And so the paper aims at having a camera in each coach which constantly monitors the coaches and also captures images every time the train is in motion after waiting in the station. After which it calculates the average number of passengers on the basis of the pixel density of the image and thereby notifies the passengers in the subsequent stops on which compartment to get in. Thus this method is created which focuses on proximity and estimation to bring down the complexity of crowd in order to manage the movement of the crowd at each layover.

The other crowd control systems use a continuous video capture which reads the movement of the people accordingly and so there is more focus on reading the movement on people rather than using it to reduce the congestion of the people during the journey. Considering a scenario where the security needs cannot be negated and most of the current crowdsourcing systems has a fallacy by just calculating the number of people waiting for the train not people who already present in the train and hence even though they are constantly monitoring it the data is not put into proper use. This thereby solves the problem of any compartment being over crowded or empty. The passengers can be notified via an app or through the information display in the stations.

2.1 IMAGE ACQUISITION EVENT:

The crowd management system continuously waits for the train to cross a particular place like the previous station before it enters the platform of the next station, every time it crosses that spot in the previous station the camera clicks a photo of the passenger compartment. The idea of having separate image processing modules is ruled out because of the price of installing the modules. However a single module is used for a train having more number of compartments, the cost of wiring will be high and will introduce delay problems. Hence a suitable trade-off is to be made when considering the issue and it is entirely dependent on the user.

The image acquisition event is based on the FIFO event where the compartment crossing the event mark point will be served first and the consecutive compartments. Similarly the event will be followed by the other trains respectively. The information regarding the compartment will be displayed according to its estimated position in the platform thus making it easier for the passengers.

2.2 IMAGE ACQUISITION:

A video camera feed continuously records the activities that happen in the compartments respectively. This camera is placed in a strategic position at one of the ends of the compartment so that it monitors the rate of people in the compartment every time the train stops and resumes motion again, when It crosses a particular pre marked point before entering the next station the image is captured, the main reason for this placement is to cover area where people are most likely to stand and wait in the train. Snapshots can be taken every time the train resumes motion.

As this is just to estimate the rough capacity of the compartment. The camera used for image acquisition can be simple VGA cameras that can take snaps at 640x480 resolution and capture video at 30 frames per second. The reason for the lesser resolution is reflected on the simplicity of hardware required to process the images and also the lesser time required for execution of these images. Since the event manager follows an FIFO method the compartment which crosses the pre marked position first will be captured and processed and subsequently will be done for other compartments.

2.3 IMAGE PROCESSING:

There will be a video camera running covering the compartment, every time the train halts and resumes motion again, the video camera captures the image of compartment. There are cases wherein people tend to climb in compartments that are overcrowded and hence the inaccuracy of the camera in capturing the density of persons in the image.

Thus to overcome this drawback, the camera is made to capture multiple images at fixed delays and makes use of the latest image, i.e. the last known image. By using canny edge detection method in image processing we can edge out people in the compartment, thus finding how densely this compartment is occupied, this information can people the can occupy the compartment in the next stop. With the help of the comparison table and proximity module we can compare the capacity of the compartment and accordingly notify the passengers waiting in the consecutive stops.

2.4 COMPARISON:

The final output obtained from the image processing module is a value that corresponds to the number of white pixels that are present in the image. This is a direct measure of the number of edge pixels that correlate to the number of persons in the image or the density of people in the image. This is done by creating a table with approximate values that are decided based on field calibration and is dependent on the area where the module is deployed.

2.5 ESTIMATION:

The capacity of compartments are determined based on four simple categories, they are full, half full, or almost empty and empty, hence the same is notified before the train reaches the next stop. Thus making it easier for the passenger to adjust their position in the next station respectively and wait for their desired compartments show that they can travel peacefully without struggle.

2.5.1 Operation:

The crowd management system can be explained based on the module that takes into account of the proximity of the train and also the capacity constraints.

Let us consider the a Train named T1 and it has 5 compartments C1,C2,C3,C4,C5 respectively, let us consider it is in station S1 and Platform P1 and the next destination is station S2 and Platform P2.

Let us assume that T1 current position is in S1, P1, once all the passengers have boarded and de boarded the train, T1 leaves S1 towards S2, let the journey from S1 to S2 be approximately five minutes. Once the last compartment C5 exits the P1 the video camera will take a snap and will send it to the centralized server where the image will get processed and decide under which four criteria will the compartment will fall under and the result will be available in P2 at S2 before the train enters S2 itself.

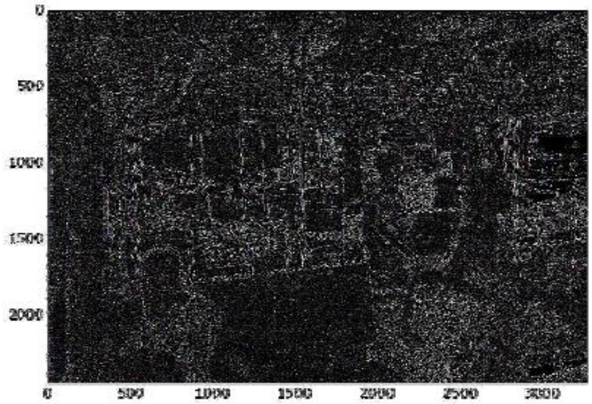
III. REAL TIME ANALYSIS:

The real time analysis can be explained step by step by taking the help of the images captured. Below steps depicts how exactly this intelligent crowd management system will function.

The last stage in the crowd management system is image processing and using the processed image to identify which compartment will suitable for respective passengers. Image processing here refers to the identification of how full each compartments are in each which falls under four categories as full, half full, almost empty, and empty. This is using a straight forward approach. Edge detection technique is used to find the density of people travelling in the train compartment. The rgb (color) image taken from the VGA camera is first converted into grayscale format. The grayscale image is fed as input to the canny operator. The canny operator is a function used commonly in image processing.

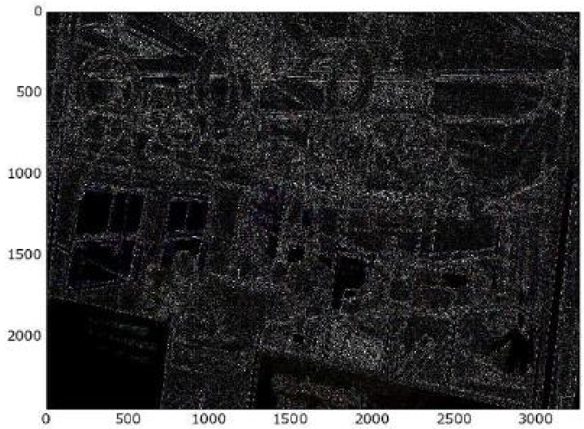
The number of edge pixels that are traced can be calculated and the approximation can be used to find out the density of the crowd in the compartment. This however requires precise calibration as real time scenarios are always different. The calibration is done at regular intervals and a table is created for reference. The table is also updated at regular intervals to reduce the errors in identification process.

Figure 2 a) it is an rgb picture from Compartment 1 (Almost full)

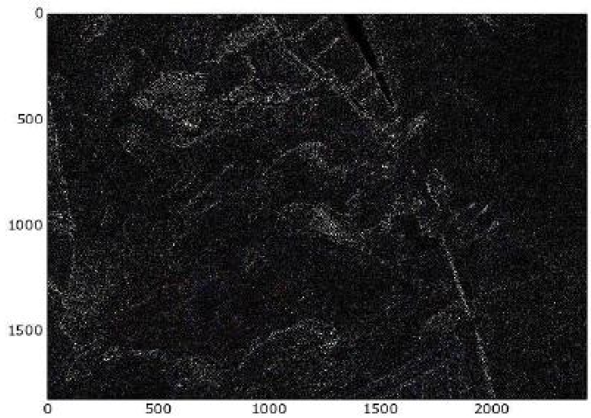


(b) Edged image of Compartment1(Almost full)

(c) rgb image of Compartment 2(Almost empty)



(d) Edged image of compartment 3 (Empty)



(d) Edged image of Compartment 2 (Almost empty)

(e) rgb image of Compartment 3 (Empty)

The resultant images from various compartments are shown above represents three different category full, almost full and empty. As you can see above all these images are taken from different trains except for the last two images and this was done deliberately so show how value change for each train and how calibration is important for specific model a train.

The Number of pixels that do not correspond to black values are counted. This values is normalized and tabulated.

Table 1: Table containing a list of approximated values based on the edge pixel count. This is a calibration step varies from Train to Train

Number of non-zero pixels in the resultant image	Normalized count value	Category
463590	1.89	Full
624240	1.580	Almost full
624240	1.04	Empty

Table 1 shows the number of non-zero pixels in the final canny image, the normalized count value and the approximated number of persons in the image. The above table gives an approximate evaluation of the density of people in the compartment. The number of non-zero pixels in the table depends on the number of people in the comaprtment. Hence proper calibration of the camera system is vital for efficient functioning of the system. This can be accomplished by strategic placement of the camera that is used for image acquisition. Also the number of pixels is dependent on the size of the image and hence we use the normalized values instead of the original pixel values to avoid confusion and maintain an operating standard.

CONCLUSION

This paper is aimed at introducing an improved crowd management system that offers more flexibility and takes additional parameters like density to decide on the optimum train crowd management system.

Furthermore the algorithm can be extended to adapt to various scenarios like different kind of train interiors. This technique can also be implemented using low cost hardware that makes it a suitable economic option to be employed for real time usage.

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