Urban Sensing

Factors Influencing Overstepping The Yellow Platform In The NYC Subway

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17-May-2019

Contents

Introduction

The New York City Subway is an incredible asset to the city, having approximately 1.7 billion counts in ridership annually[1]. The subway is essential in getting people where they want to be, to escape the seemingly endless gridlock of traffic out on the road. Therefore, avoiding delays is an important aspect the Metropolitan Transportation Authority (MTA) must constantly be wary of.

One frequent source of delays are people falling over to the platform and possibly being struck by the train. There are above 150 incidents annually of people being struck by trains in at the NYC subway[2]. There is a platform marked yellow near the entry point of the train in every station. This serves as a warning indicator and MTA advises ‘standing on or at the yellow platform edge strip is dangerous.

We believe that the primary reason is people overstepping onto the yellow platform, which puts them at potential risk of falling over and being struck by the train[3]. In this project, using video and LIDAR sensors, we wish to explore the factors involved that make the people do so.

Hypothesis / Problem Statement

We have mainly 2 hypotheses:

1. People step onto the yellow platform due to the platform being overcrowded.
2. People step onto the yellow platform due to space-constrained subway platforms.

Data Collection

Location

We decided to collect data at the Jay Street MetroTech Station, specifically the R and A-C-F platforms.

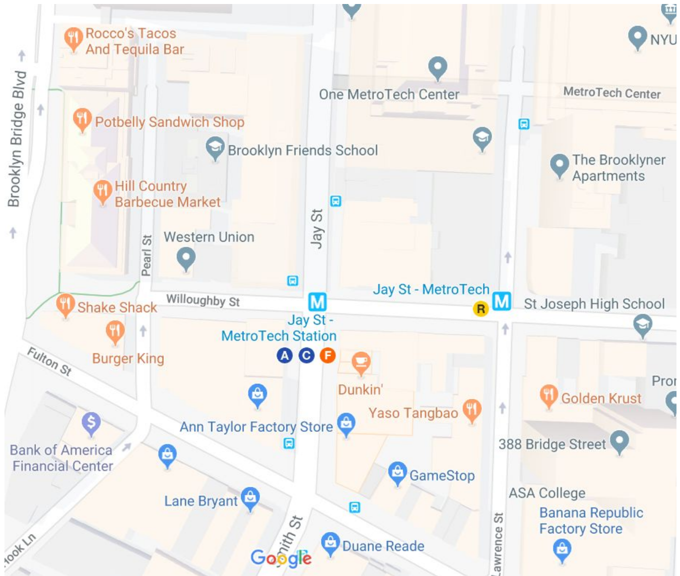

Fig 1: Google Maps image of the location

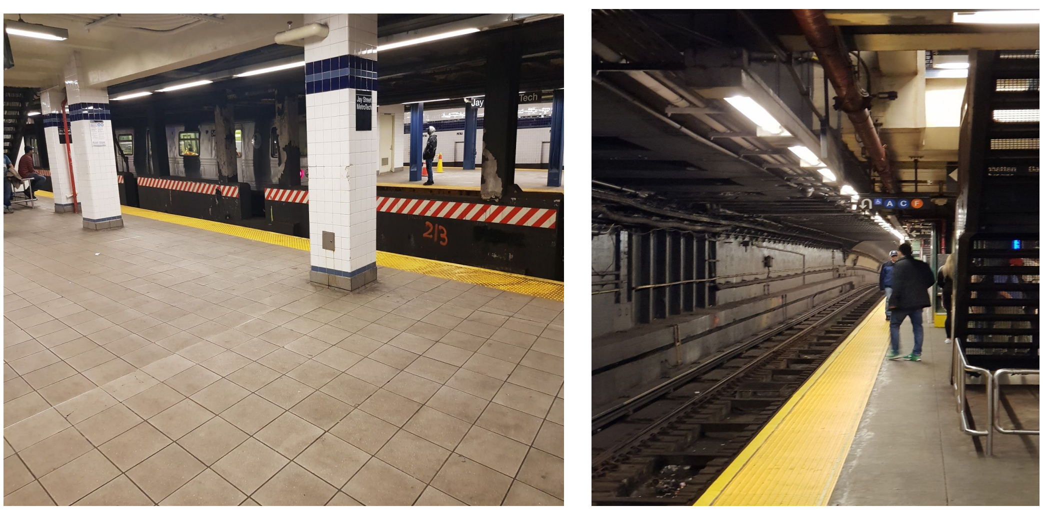

Fig 2: A-C-F (left) and R platforms at Jay St MetroTech station

Sensors Used

We have used 2 sensors for this project:

1. **GoPro Hero 3+** camera placed on a tripod to capture video.
2. **Riegl VZ-2000i** (laser scanner) to get LIDAR data for the subway platforms.

LIDAR

We underwent the laser scanning operation on an early Saturday morning to try and have as few people as possible to avoid occlusions in the scans. We placed the scanner at various points across the platforms and placing targets at appropriate locations in order to stitch the readings together in the end.

Video

After finding good vantage points which captured the yellow platform crossing clearly at both the R and A-C-F platforms, we took 20-minute videos for rush hour (8:30 AM) and non-rush hour (10:00 PM) respectively. The videos were captured in 60 FPS and were approximately 3 GB in size each.

Data Processing

LIDAR

We analyzed the LIDAR scans for both platforms using the software CloudCompare, searching for the shortest point between the yellow platform and an obstructing object like a pillar, staircase or a shop stall. As shown in Figures 3 & 4, we see the R platform having a distance of 0.83 units and the A-C-F platform having a distance of 2.3 units. That is approximately three times the difference between the two stations.

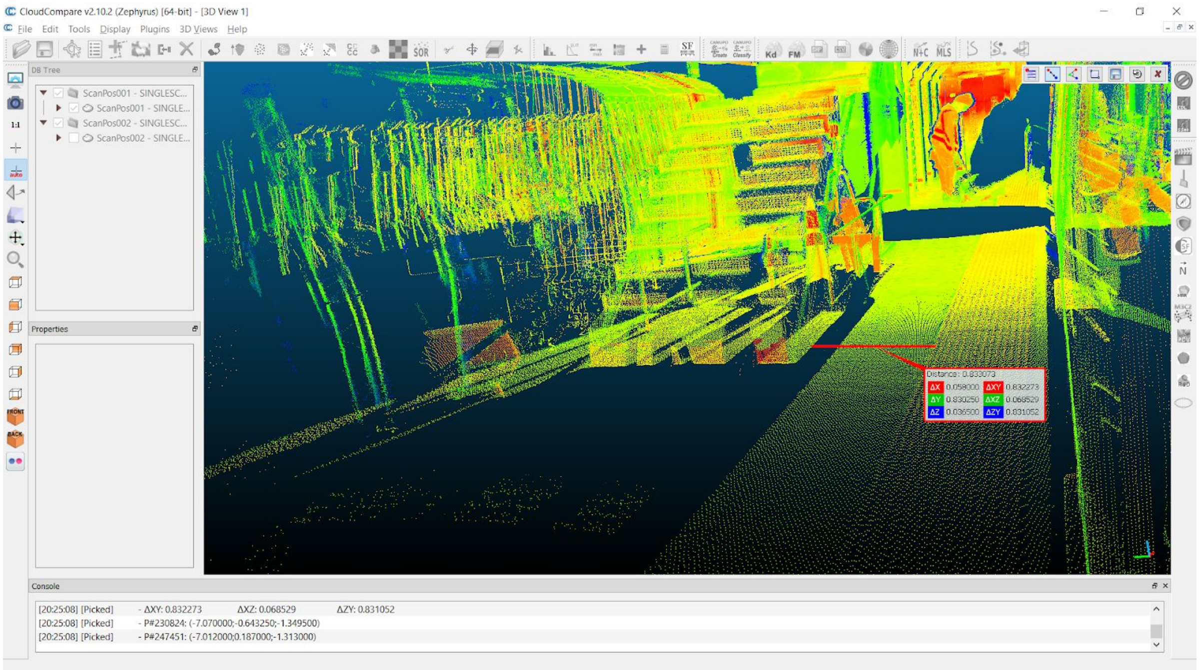

Fig 3: LIDAR scan of the R platform

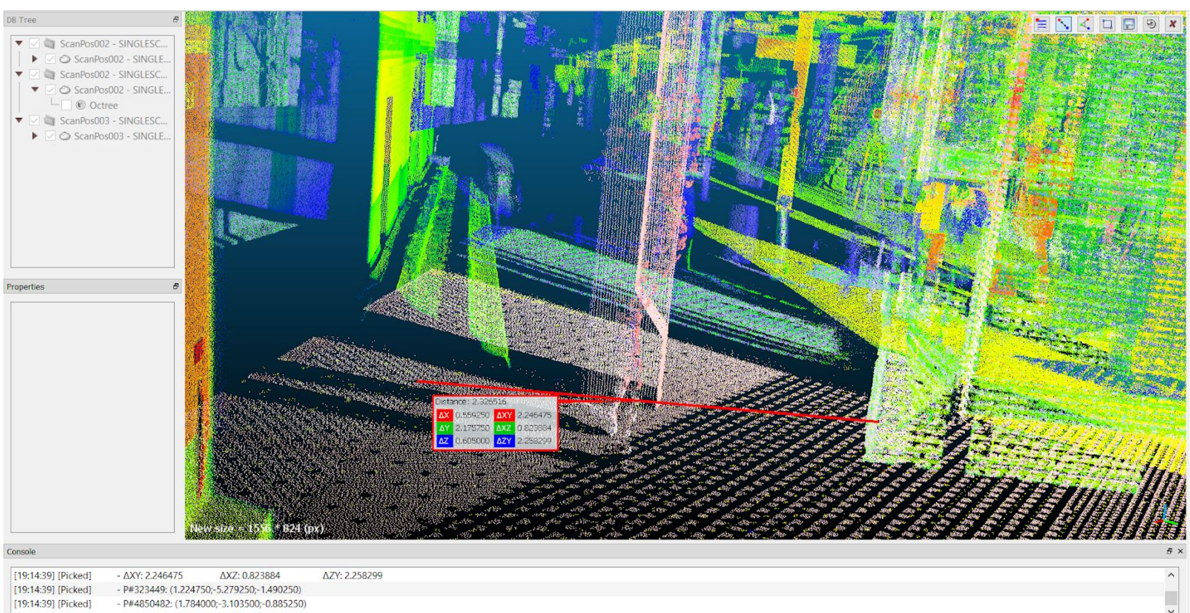

Fig 4: LIDAR scan of the A-C-F platform

Video

We used the OpenCV library of Python to process the video data we collected. In order to detect the people as well as the train, we used a pre-trained Caffe Object Detection model[4] on a simplified version of the CoCo dataset[5] containing 20 different classes instead of the 80 original categories. Next, we had to detect the yellow strip as we were interested in number of times people crossed this. There are automatic line detection methods like Hough Transform but, that would increase the computation time as the algorithm will have to run for each frame of the video so,we just decided to make a static line at the start of the video.

Also, we wanted to look at the counts of the people crossing the yellow platform in a normalised manner as the percentage of people is what is significant and the absolute count. This is because there would be lesser people on the platform during non-rush hour; so less people would cross the yellow strip and the result would not be significant. So,we capture the number of people crossing as well as the total number of people on the platform.

Another thing for consideration was what to do about the parts of the video when the train is there on the platform. We tried to detect the train and make the model stop counting people during the time when there is a train in the frame. This worked well for the R platform but, it was messing up on the A-C-F so, we decided to manually trim the parts of the video when there was a train on the platform and run the code on the rest.

Fig 5: Methodology of Video Processing

Results

Shown in the below figures are the number of people who crossed the yellow strip and the total number of people on the platform for each of the 3 videos collected by us. As seen below, there are 1.8% crossing on the R-platform during non-rush hour while there are 6.7% crossings on the same platform during the rush hour. While for the A-C-F platform, there are zero percent crossings during the non-rush hour.

Fig 6: R-platform non-rush hour results

Fig 7: R-platform rush hour results

Fig 8: A-C-F-platform non-rush hour results

Discussion

In addition to the platform design and the overcrowded platforms being a reason for people overstepping on the yellow platform, we noticed that some people tend to do it despite not having any reason for doing so. Our understanding for the same is that people tend to do as they like as long it is not illegal (most of them, anyway). So,there should be stricter enforcement or a law making it prohibited to cross the yellow strip when there is no train on the platform in order to stop people from crossing this. Also, MTA should actively spread awareness for this similar to the announcements and posters about not walking between subway cars unless there is an emergency.

Conclusions

From our analysis, we were able to conclude that the platform size and the density of people on the platform does affect the choice of people to walk on the yellow platform. But, we cannot conclusively say that these might be the only reason for people to do so as we have noticed people doing it without any reason also.

Challenges Faced

Occlusions were a major hindrance for the project which included both people coming in our way during the video collection and the actual design of the platform. In case of the LIDAR data, we had to scan the various parts of the platform separately and stitch them together and we were not able to capture all the people because of other people being closer to the video source and blocking the field of view.

Also, people are naturally attracted by and inquisitive about fancy equipment like the LIDAR sensor. These occlusions reduce the preciseness of our analysis by adding noise and this further caused some problems like MTA crew and the police asking questions about the permit and the project. Additionally, this was our first experience working with LIDAR and video data; so, we were learning as we moved ahead and weren't able to process it as efficiently and utilize a few in-built programming functionalities as effectively as we should have.

Future work

Another reason why we cannot give conclusions with a lot of confidence is that our chosen sample is very small. We are doing the project just inside the Jay-Street Metrotech Station and we are collecting the video data only from a single point on each platform. So, in order to do some data-driven policy making, we would need to scale this analysis in such a way that the entire city of New York is well-represented. Also, we would like to build the object detection model in such a way that it detects the train more accurately and so, we do not have to just trim that part of the video out which makes it easier to reuse and scale.

References

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