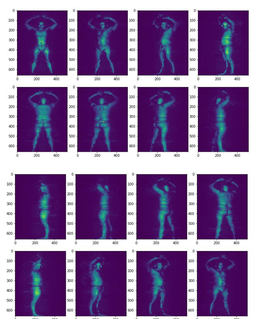
UC San Diego
JACOBS SCHOOL OF ENGINEERING

Threat Detection Using AlexNet on TSA scans

Amartya Bhattacharyya, Christine H Lind, *Rahul Shirpurkar*

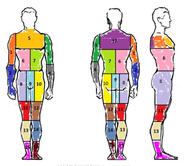
OVERVIEW

- Strong opposition against, the use of body scanners by TSA led to court proceedings from 2008 – 2017.
- Last year TSA made the use of body scanners mandatory for all travelling passengers. For detection of non metallic and odorless threats.
- People still opt for Pat downs over the body scanners due to concerns over privacy infringement and potential health issues.
- This project works on the data from millimeter-wave scanner, solving the problem by replacing the human element with ML.
- We decided to use a Convolutional Neural Network as it is well suited to work with images as inputs and process them.
- CNN makes the forward function more efficient to implement and vastly reduces the amount of parameters in the network.
- The inputs consists of body scan data in the form of images obtained from a Kaggle competition .

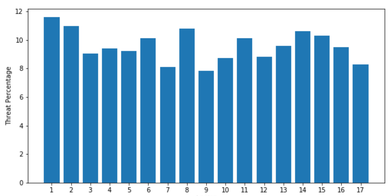


DATA

- 1147 Projected Image Angle Sequence Files (.aps)
- Each File: 16 2D Frames Equally Spaced in Angle
- The body is divided into 17 regions to make the implementation faster



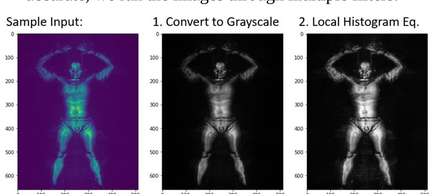
Region	Threats	Total	Percent
1	133	1147	11.595466
2	126	1147	10.985179
3	104	1147	9.067132
4	108	1147	9.415867
5	106	1147	9.241500
6	116	1147	10.113339
7	93	1147	8.108108
8	124	1147	10.810811
9	90	1147	7.846556
10	100	1147	8.718396
11	116	1147	10.113339
12	101	1147	8.805580
13	110	1147	9.590235
14	122	1147	10.636443
15	118	1147	10.287707
16	109	1147	9.503051
17	95	1147	8.282476



- We started with sections 5 and 17 because theses regions are flat and we knew for sure that the threat would be guaranteed to be visible in a single slice.

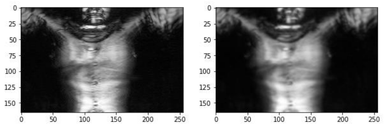
Data Preprocessing

•To help make feature extraction more efficient and accurate, we ran the images through multiple filters:



•The images were then randomly flipped on their axes to prevent bias

•We used smoothing in region 5 to blur out the faces because we realized that the faces were causing inaccuracies in detection.



MODEL

Why AlexNet?

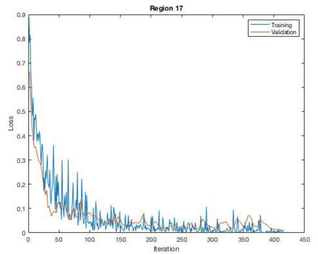
- AlexNet is a convolutional neural network designed by the SuperVision group, consisting of Alex Krizhevsky, Geoffrey Hinton, and Ilya Sutskever.
- It achieved a top-5 error of 15.3%, more than 10.8 percentage points ahead of the runner up.
- AlexNet contained only eight layers; the first five were convolutional layers, and the last three were fully connected layers.

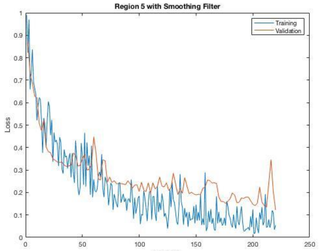
- In the MATLAB implementation of AlexNet, the 8 of layers are sub-divided into 25 layers

RESULTS

•The sample size for region 5 is 212 and region 17 is 190.

•The aspect ration was sample size*0.8 for the Test data and sample size*0.2 for the validation





	MINIMUM LOSSES	
	Training	Validation
Region 5	0.0139	0.1221
Region 17	0.0006	0.0088

DISCUSSION

- In region 5 we achieved 20% log loss error using AlexNet without smoothing. It improved to 12% after smoothing.
- For section 17 we achieved 05% log loss error.
- This difference was faced due to the interference of the facial features in section 5.

FUTURE WORK

•The inclusion of faces in the data was causing issues. For the future, we would have implemented an automated cropping algorithm.

•To find a way to crop the body into 17 regions automatically

•Develop an implementation capable of identifying presence of threats on curved/hidden portions of the body- such as inside of arms

•Include all 16 slices (views) to detect all possible threats.

•Experiment with filters to improve accuracy.

REFERENCES

•Abel Ag Rb Guimares and Ghassem Tofighi., “Detecting Zones and Threat on 3D Body for Security in Airports using Deep Machine Learning.” CoRR. 2018.

•Nicolas Jaccard, Thomas W. Rogers, Edward J. Morton, Lewis D. Griffin. “Using deep learning on X-ray images to detect threats.” CoRR. 2016.