# Moving Target Classification Through RADAR

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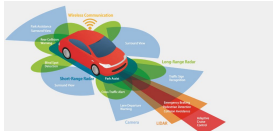
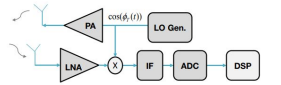
## Introduction and Motivation

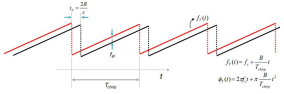
### Introduction

- Commodity radars are being increasingly integrated in commercial vehicles to support new Adaptive Driver Assisted Systems (ADAS) features due to its potential for high measurement accuracy (location,velocity and angle) that is largely independent of environment conditions.
- However, the feature requirements from such radar sensors have increased steadily from lower level detection and now include tasks such as environmental perception that requires object classification.
- When the system is fully implemented it will take in radar signals and be able to classify different types of moving objects, specifically cars, pedestrians, and bicycles.

### What is RADAR?

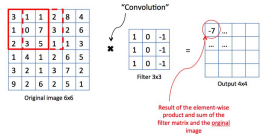


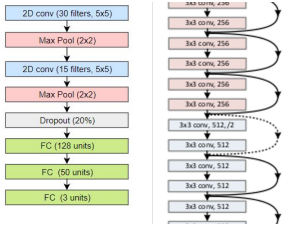


## Models - CNNs

- CNN stands for Convolutional Neural Network.
- How a convolution works is outlined in the image to the right.
- A CNN consists of several convolutions stringed together, resulting in a network.







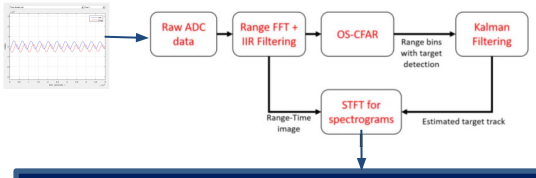
- CNNs are generally good at performing image based analysis.
- To this end several classical CNNs were implemented and tested on the radar data.
- These include a simple LeNet like network, AlexNet, VGG16, and ResNet50.

## Results

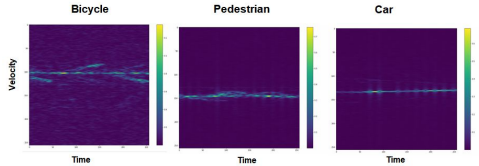
- Our results for the various different networks can be seen in the table below.
- Overall the CNNs performed better than the RNNs, and the VGG16 network got the highest overall performance at 99.1%.
- This is impressive as the current state of the art for RADAR is at 93%.

| Dataset/ Network | VGG_like | AlexNet | VGG16 | ResNet50 | RNN | RNN/CNN |
|---|---|---|---|---|---|---|
| Training | 97.3% | 100% | 100% | 99.6% | 100% | 99.3% |
| Testing | 87.7% | 98.5% | 99.1% | 98.5% | 94.6% | 95% |

## Data Preprocessing Flow

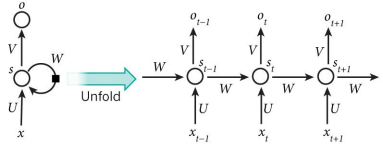


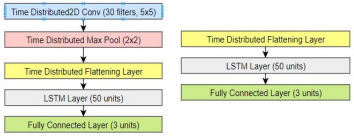

## Data Preprocessing Results




## Models - RNNs

- RNN stands for Recurrent Neural Network.
- How this type of network works is outlined in the image to the right.




- Since the radar data has a time element, it can be treated as a sequence of images.
- This sequential structure may provide additional useful information.
- An RNN along with an RNN with leading CNN layers were tested.

## Challenges and Future Work

- One issue we faced was that the initial size of the data was too large.
  - This caused the network to be too big and caused memory issues.
  - We had to strike a balance between making the data small while still retaining the critical information.
- Another issue was that our dataset was fairly small at roughly 5000 images.
  - This may seem large but in the world of big data this is tiny.
  - For future work we will need to train/test the model with more data.
- Another future work would be to expand the number of classifications.
- Currently the network can tell the difference between pedestrians, bicycles, and cars, but it would be interesting to see if the network could work with more groups.