



Development of Machine learning model using Simulink

```
noCameraSensor.  
peopleDetector(ACF  
[0.5, 1.5];  
configureDetect
```

How is the talk paced?

- Introduction
- What is the Problem
- What is the approach&solution
- What tools are used to Realize it
- What are our Observations
- Results

Stock



$x=8.8, y=0.8$



Introduction

- INTRODUCTION OF BS4 REGULATIONS
- ECU + SENSORS
- ECU CAN RUN A HOST OF PROGRAMS
- BETTER INFORMATION PROCESSING
- ECU + SENSORS + ALGORITHMS
- CAN MACHINE LEARNING BE USED?



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Problem Statement

What is the problem?

- **Road Surface and its condition** is a critical parameter for vehicle operation
- Diversified categories of road with different terrain combinations
- Terrain change needs a change in driving style

What can I predict if I somehow know the road condition?

- Tire life and wear
- Vehicle Durability and aging impact
- Fuel Economy Impact

How can I know the road condition?

Use Machine Learning to Classify Road Condition

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Step 01: What are the Road Conditions

*National Highway / Expressway (Four / Six Lane)
Operating Speed 60 ~ Max. Speed (Kmph)*



A
Class

GOOD ROAD

*Single Lane State Highway / City Route
Operating Speed 20 ~ 50 Kmph*



B
Class

GOOD ROAD

*Broken Tar Road / Village Road
Operating Speed 20 ~ 30 Kmph*



C
Class

BAD ROAD

*No Road Condition / Damaged Road
Operating Speed < 20 Kmph*

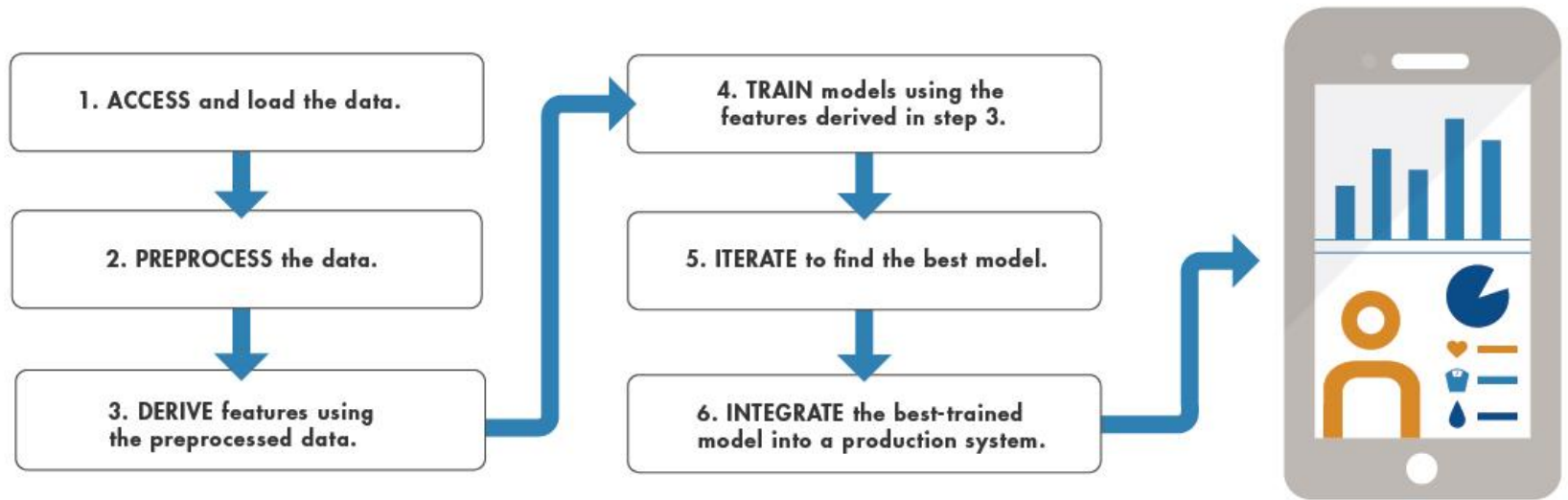


D
Class

BAD ROAD

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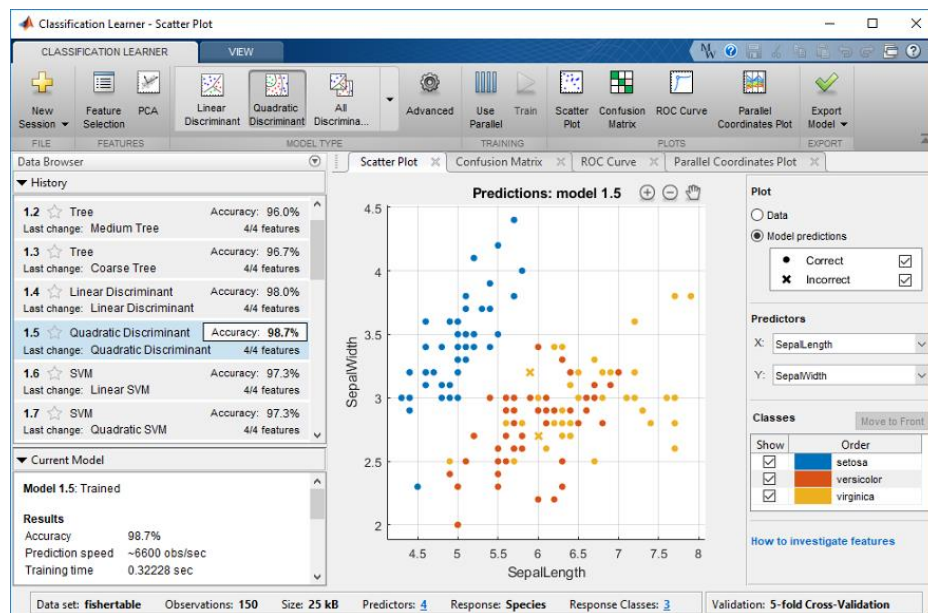




The Machine Learning Way?

Our Workflow

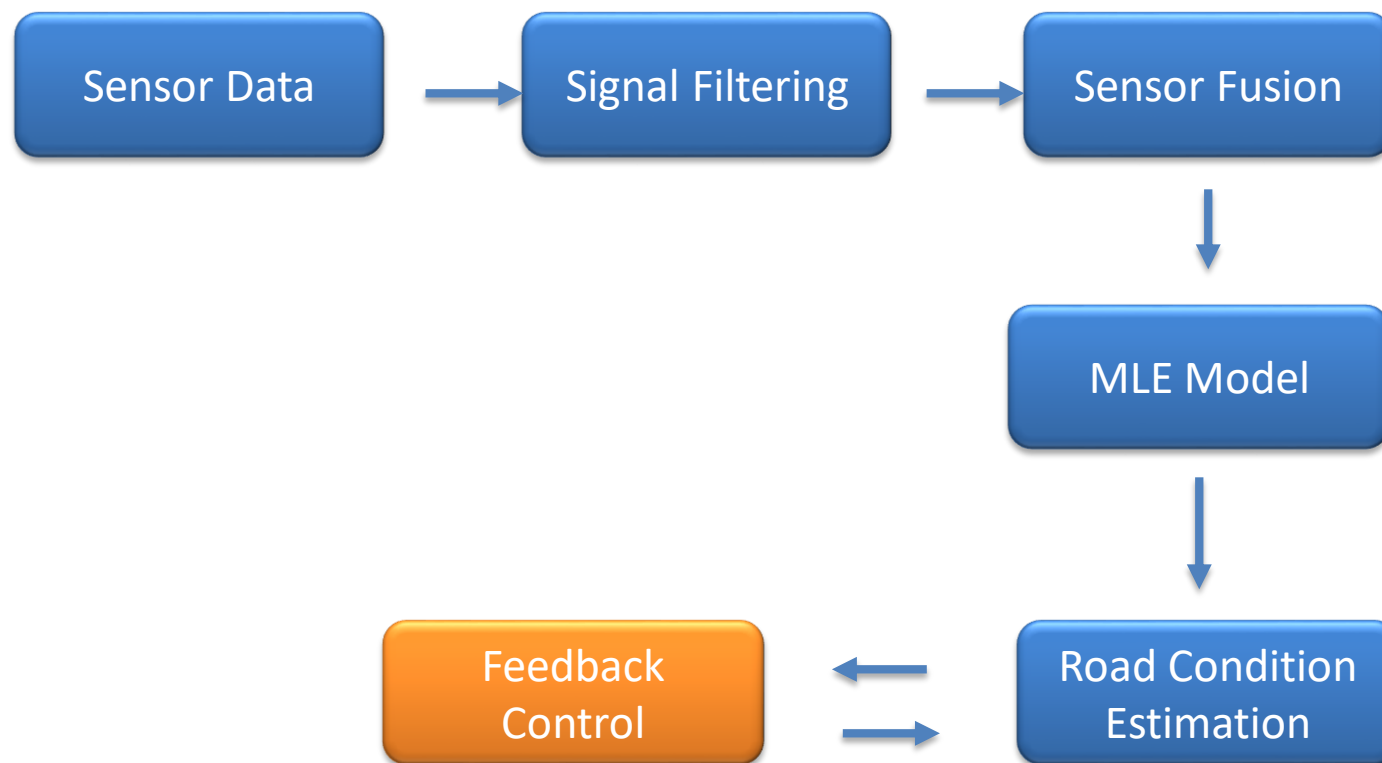
- Internet Study
- Collect and Label Data
- Process Data
- Extract Features
- ML Model is generated using **Classification Learner Application**
- Then, ML Model is Optimized
- Build Model in Simulink
- Generate code and flash it on to a target hardware



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Block Diagram of the Simulink Model

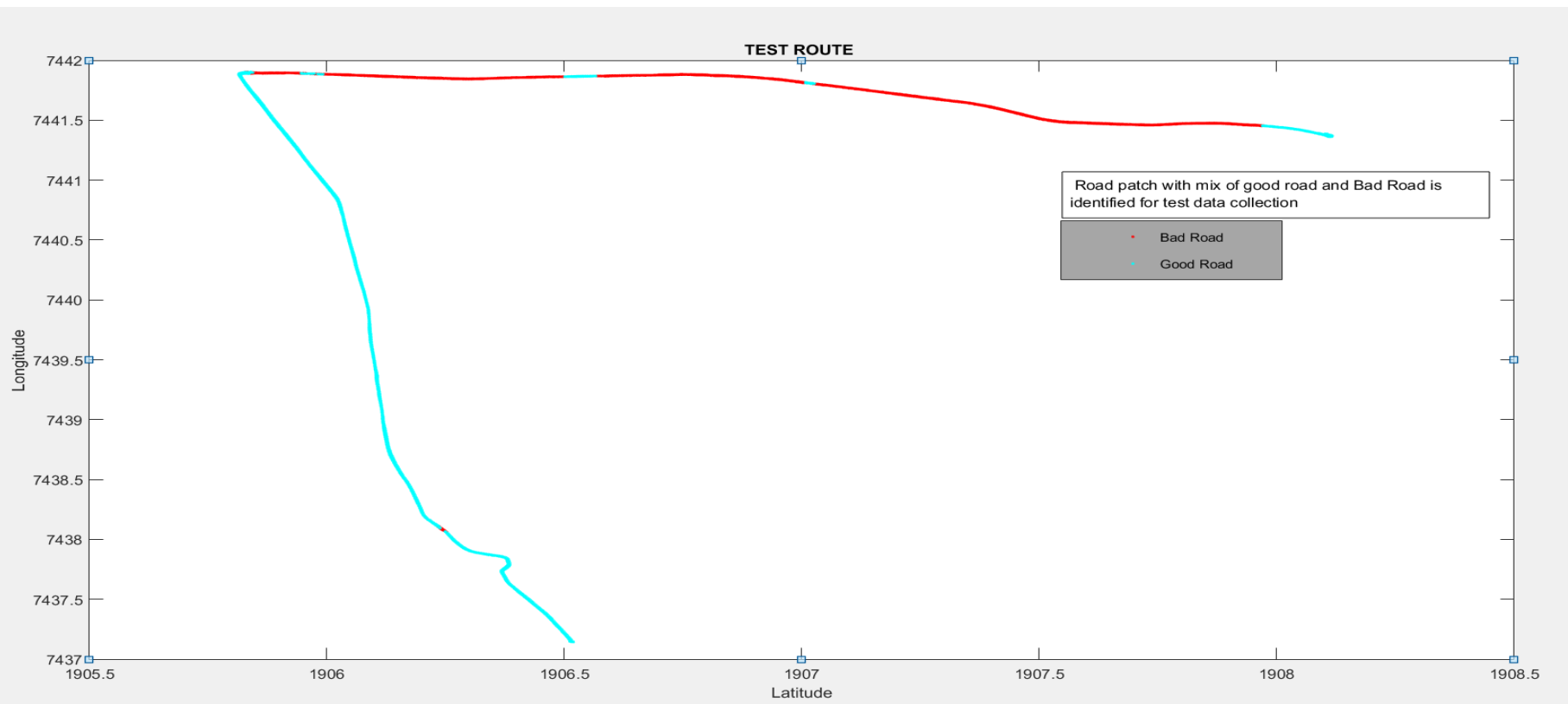


Can serve as input to other algorithms

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Ground Truth Labelling



Ground Truth Labelling is done by manually mapping the route as per road condition during vehicle data collection trails .

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Data Analysis and Feature Extraction

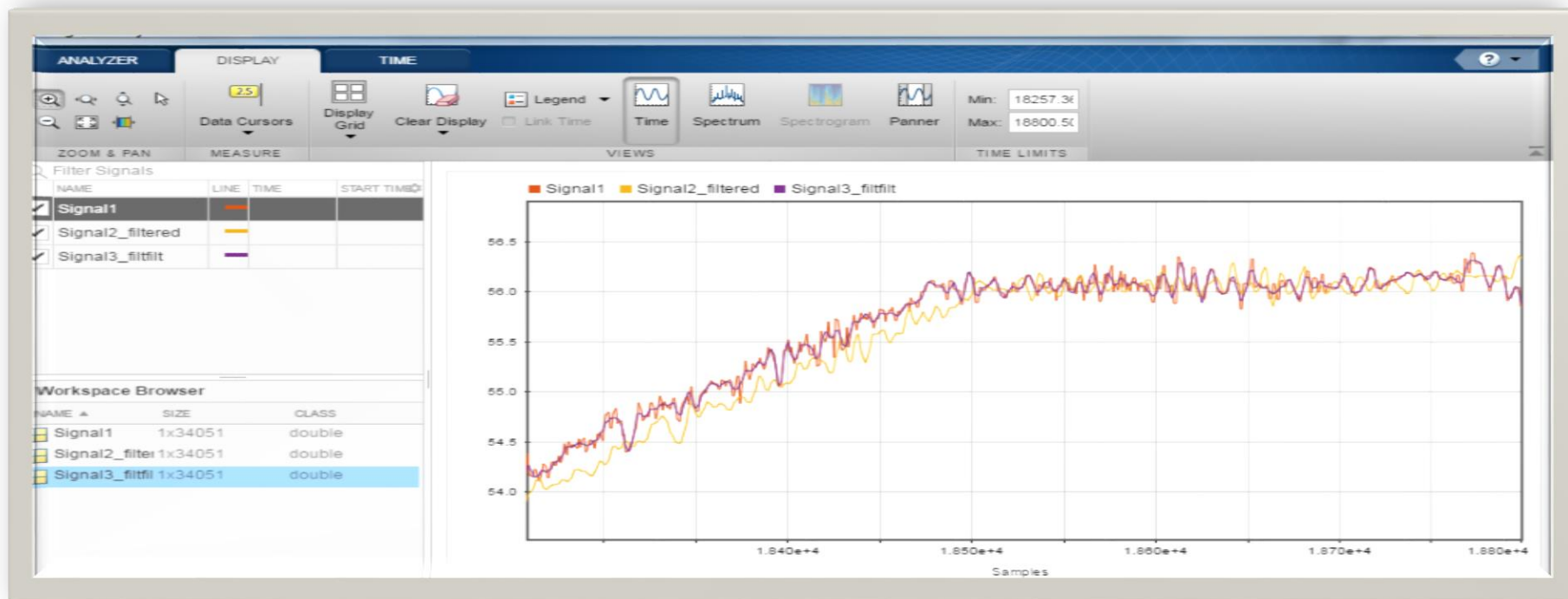
- Identify Key Variables
- Data Analysis
- Analyze and Extract Features



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Approach & Methodology (Digital Signal Analysis)

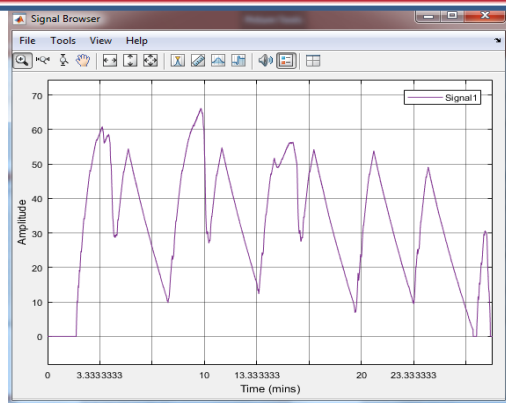


- **Filter Designer tool** is used to design a low pass filter of required order and transition band.
- To analyze original as well as the filtered signals in time and frequency domain, **Signal Analyzer Tool** is used.

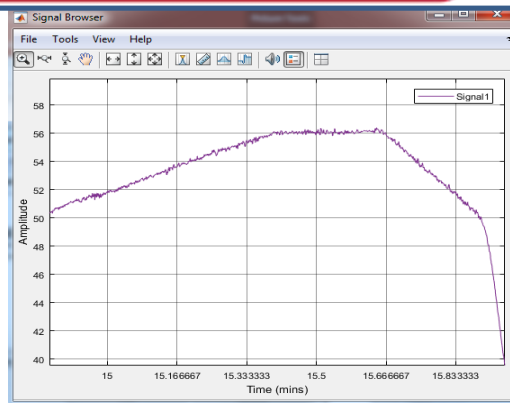
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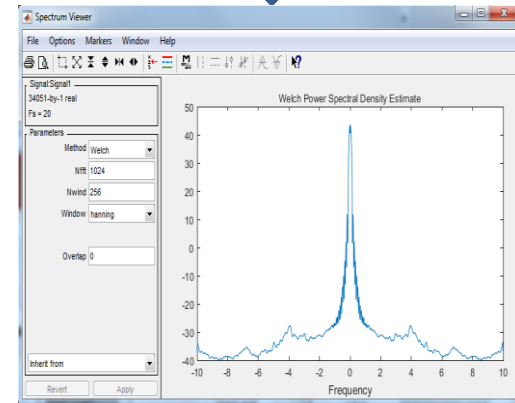
Digital Signal Processing



Raw Signal

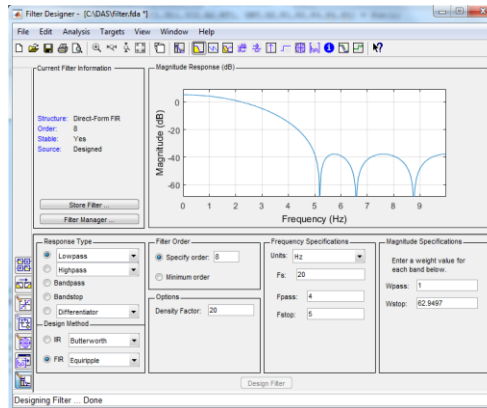
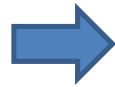


True signal + Noise

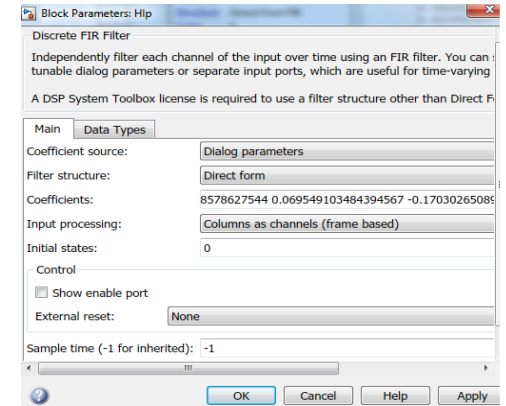


Power spectra of signal

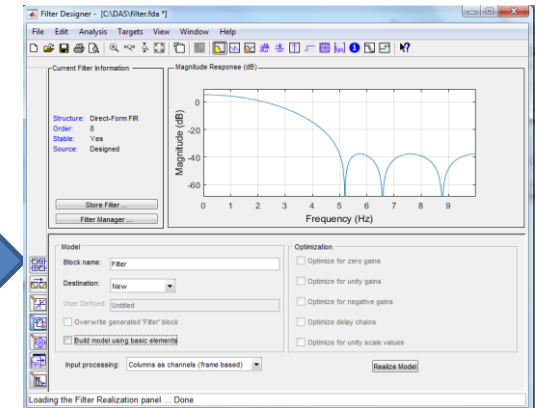
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Setting type and Frequency specifications of filter



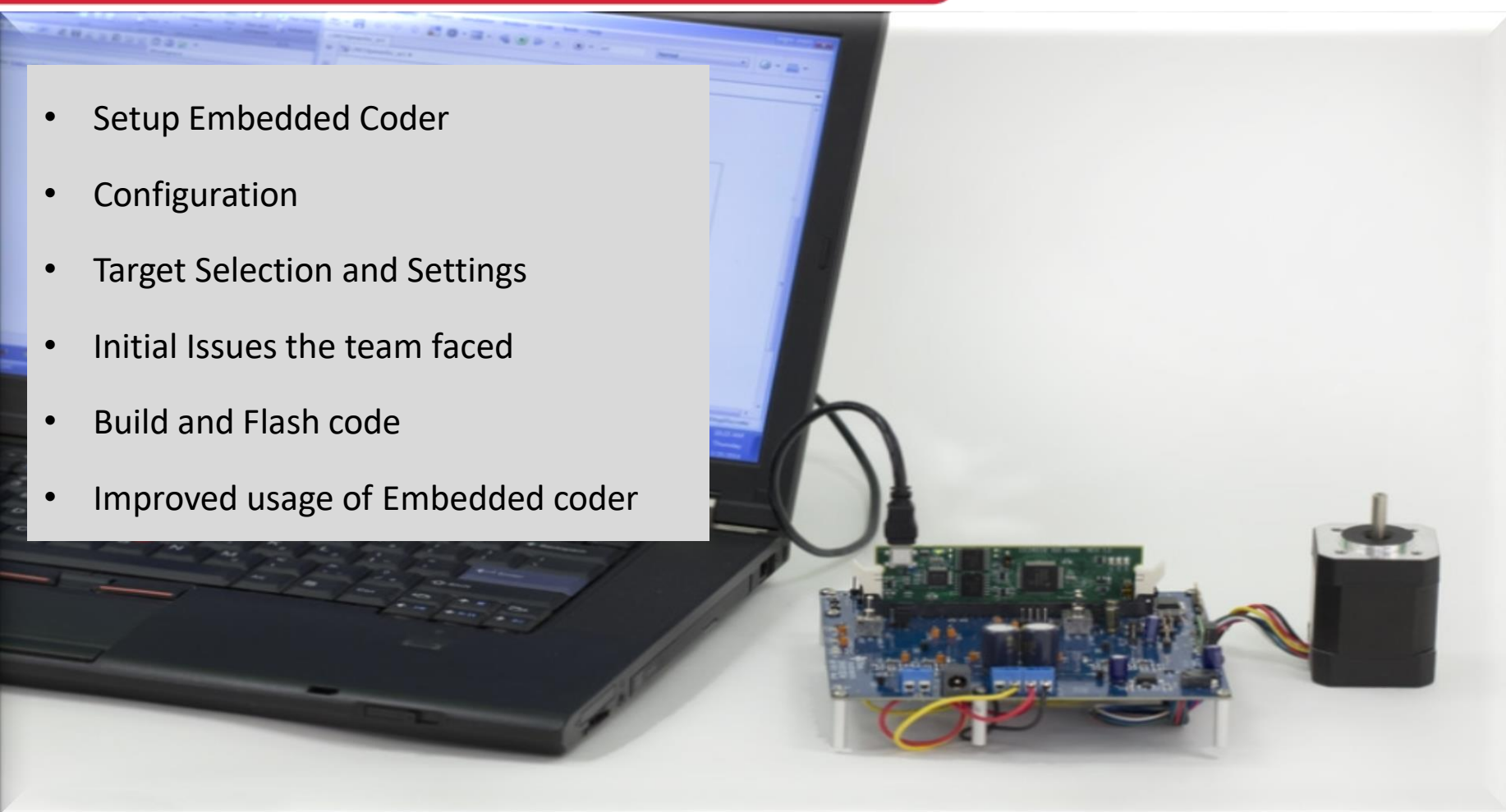
Realizing filter in simulink



Filter settings

Embedded Coder

- Setup Embedded Coder
- Configuration
- Target Selection and Settings
- Initial Issues the team faced
- Build and Flash code
- Improved usage of Embedded coder

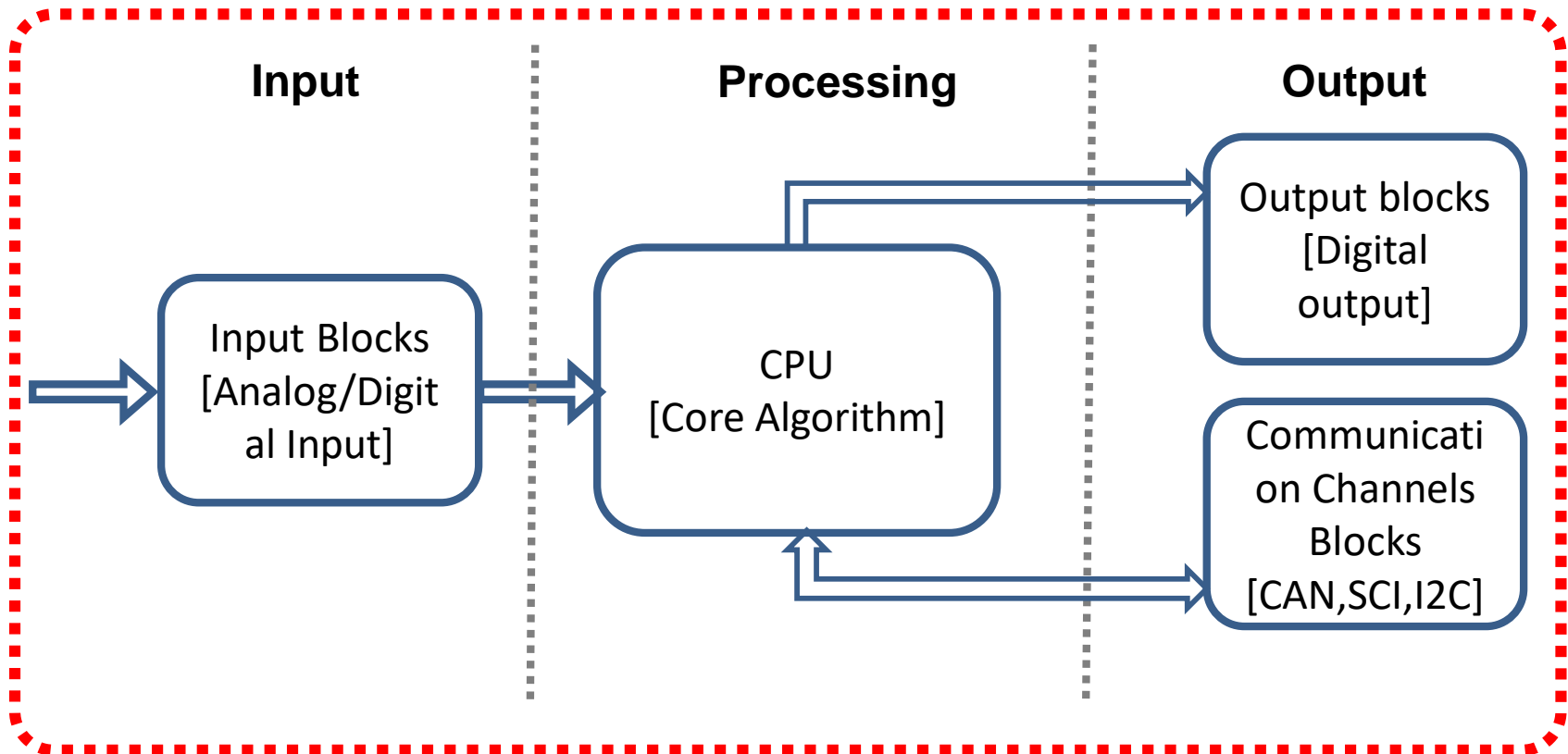


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Hardware Implementation

Rapid Prototype Controller



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Simulink Model



Results & Observations

Observations

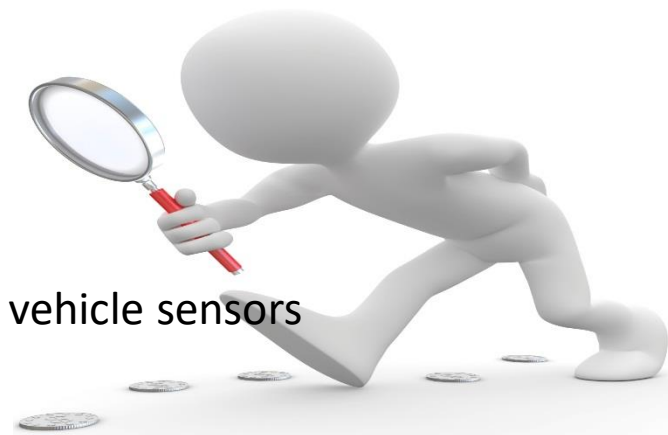
- Road Condition Estimation is possible with in built vehicle sensors
- There is a scope to define more road categories

Results

- Good prediction capabilities seen with use of ML model

Conclusion

- **ML Models might provide good initial model to predict inputs without an empirical model**
- **Simple ML model deployment is possible on controllers with limited memory footprint and there is scope to further optimize**



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THANK



YOU

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