*Traffic Warning Sign Recognition & Vehicle Plant Model Integration*

*Wei Kit Wong  
BSc (Hons) in Applied Computing  
Waterford Institute of Technology*Waterford, Ireland  
20075628@mail.wit.ie

*Abstract*—This electronic document outlines the implementation of a Traffic Warning Sign Recognition (TWSR) system that outputs an appropriate transmission response if a stop sign is detected, through the usage of an Vehicle Plant Model (VPM). This is a theoretical Advanced Driver Assistance System (ADAS) modelled in Simulink to show how Traffic Warning Sign Recognition may be used in a real-world setting in conjunction with other ADAS features.

Keywords—detection, integration, MATLAB, recognition, Simulink, traffic sign, transmission

# Introduction

TWSR systems are starting to become standard in the automotive industry, with many different implementations to produce the ADAS feature. One aspect of TWSR that is not researched thoroughly is its further application and how it can be used with other ADAS features. This project is an integration exercise of a TWSR and a VPM in Simulink, where if a stop sign is detected, an appropriate transmission response to stop the vehicle will be sent. To simulate the driving experience, a video input will be fed into the TSR system and the output of the VPM’s effect will be visualised in a graph.

# Traffic Warning Sign Recognition

This heading looks at the functionalities of the TWSR system to be implemented for the integration exercise. A review of the expected scope will be performed, and a step by step overview of how it is implemented will be provided.

## Scope

As the implementation of TWSR is not the major focus of this project, the system can be a basic model that can identify the most common stop signs, with the stop sign being mandatory for this project, i.e. such warning signs include “Do Not Enter” and “Yield”.

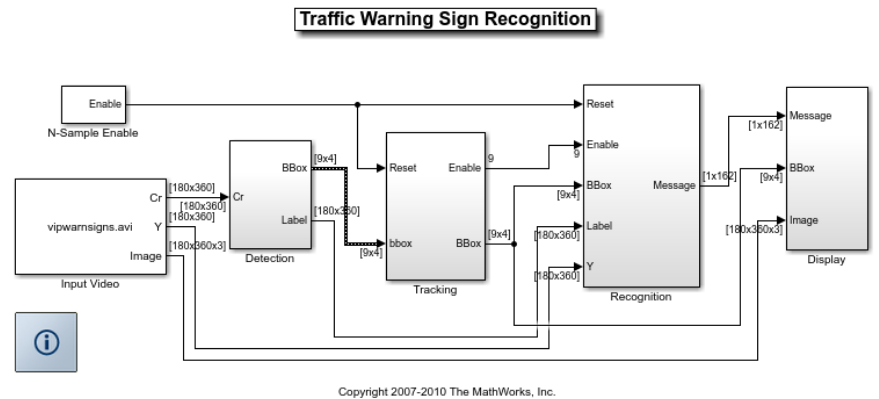
After researching through existing TWSR systems implemented in MATLAB and Simulink, the example one provided by MathWorks [1] proved to suit my needs the most as its implementation was well documented, therefore it was chosen as the base of the project as it could be easily tailored for integration.

## Implementation

This looks at how the TWSR system was implemented from the chosen MathWorks example.

To begin, the entire pipeline is divided into three steps:

1. Detection
2. Tracking
3. Recognition



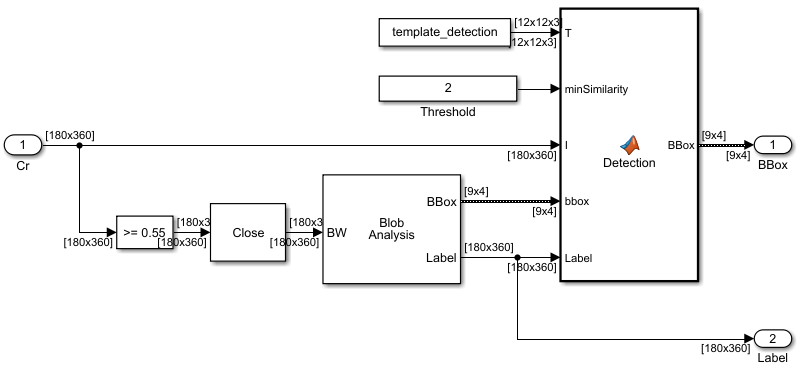
*Simulink implementation of the entire TWSR pipeline*

### Detection

After an input video is provided for inspection, the first phase of TWSR is detection. For each frame, it looks at different portions of the picture and searches for pixels that match a potential traffic sign through Blob Analysis. It performs the matching through the usage of detection templates, which are a blob representation of each traffic sign to be detected.



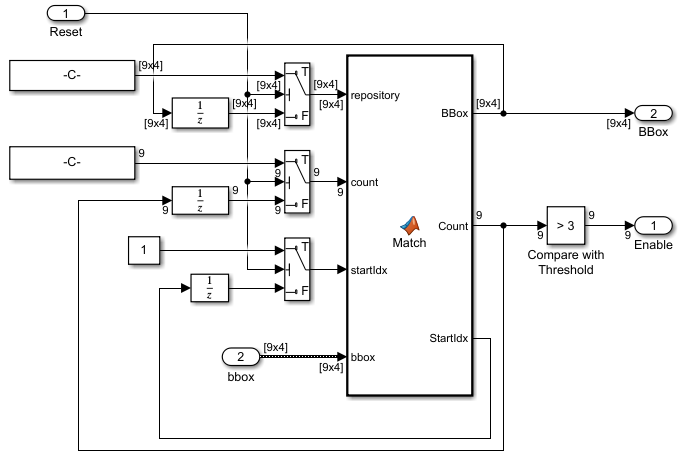
*Detection templates for each traffic warning sign.*



*Simulink implementation of the Detection step of TWSR*

### Tracking

To add onto the detection process, tracking is the last step of the pipeline to ensure what is being inspected is a traffic warning sign. Its function is to ensure that the current potential traffic warning signs being inspected were also detected in the previous four frames. This is to ensure that the blobs detected were not caused by consecutive systemic errors or outside environmental factors. This is performed by comparing the blob matches and if the blob configurations are consistent for within four frames. If this is the case, the potential traffic warning sign is considered an actual one.



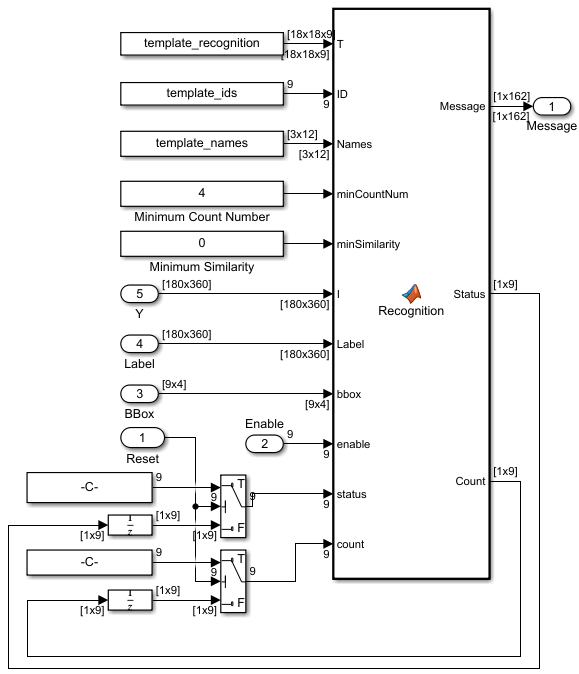
*Simulink implementation of the Tracking step of TWSR*

### Recognition

The final step is to perform the actual recognition; to determine which traffic warning sign is. This uses a similar process to Detection, but rather than using detection templates, recognition templates are used. These templates highlight the features of each traffic warning sign rather than the shape of it. By comparing each template with the sign’s features, the warning sign is derived by choosing the one that has the most approximate features.



*Recognition templates for each traffic warning sign.*



*Simulink implementation of Recognition step of TWSR*

As the purpose of the original MathWorks example was to just recognize each individual traffic warning sign in the video and highlight it, the recognition function also performs the labelling of what traffic warning sign it is. This will be used in the integration to figure out whether the detected sign is a stop sign or not.

# Vehicle Plant Model

This looks at the scope of the VPM system to be implemented and used for the project.

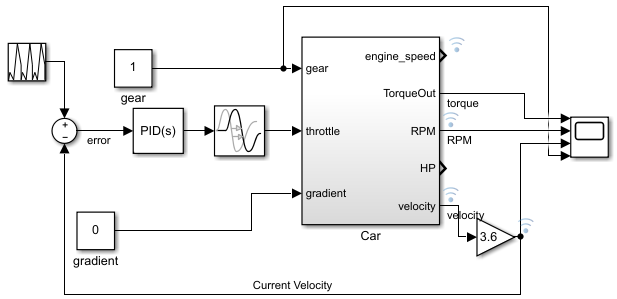
Similarly to the TSWR system, a base model will be used rather than creating one from scratch. In this case, the “Vehicle Plant Model” from last year’s Model Based Development class will be used, which simulates the action of a gearbox.

## Scope

For the purposes of this project, the existing functionalities is satisfactory for this exercise. Currently, the system accepts an input matrix of speeds in kmph that the vehicle will be going through over a time period, and the plant will perform the gearbox simulation, providing outputs of RPM, torque and velocity based on the fixed gear provided.

## Implementation

This heading looks at how the VPM system was implemented.



*Simulink implementation of the entire VPM system*

# Integration between TWSR and VPM

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# Simulink Model

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# Benchmark Testing

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# Conclusion

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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1. Uk.mathworks.com. (2019). *Traffic Warning Sign Recognition*. [online] Available at: https://uk.mathworks.com/help/vision/examples/traffic-warning-sign-recognition.html [Accessed 2 Jan. 2020].

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