MATLAB based Control of a Scaled Tractor Semi-trailer

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Internship Report

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Abstract

This document describes the control of a model truck using MATLAB/Simulink. The final objective of the project is to control a 1/14 scaled model truck from a parking lot to the docking bay of a scaled distribution centre setup.

The model truck was studied wherein, the dimensions of the model truck and semi-trailer were analysed and compared to the dimensions of an actual truck and semi-trailer to determine a proper scaling ratio; the model truck characteristics such as steering angle and turning radius were also studied to compare the behaviour of the model truck to that of an actual truck; and schematics of the model truck with semi-trailer combinations were drawn using Visio. The control for the model truck was implemented by studying the data communication of the model truck, the Radio Control (RC) setup was replaced by the Olimex E407 microcontroller; Simulink models using HANcoder blocks were built for the PC and Olimex E407 respectively to enable control of the model truck using a PC and a Logitech gaming steering wheel. Lastly, the truck is tested to compare the repeatability of the path taken for a pre-defined input versus manual control of the model truck.

Contents

1. Introduction

This document describes the work done for the TruckLab in the AES lab located at the Eindhoven University of Technology. The final objective is to control a 1/14 scaled model truck from a parking lot to the docking bay of a scaled distribution centre setup.

The automated docking system would allow the driver to hand over control of the truck to the auto docking system resulting in reduced congestion and time spend at a distribution or logistics centre. This could yield economic benefits which can be gained with a full integration of the truck with the logistics system.

The model truck used in this project is a 1/14 scaled Tamiya MAN truck. A semi-trailer accompanies the truck. The model truck and distribution centre is as shown in Figure 1.

Figure 1: TruckLab at the AES Lab.

2. Vehicle Dimensions and Characteristics

2.1 Dimensional analysis

The tractor and semi-trailer model dimensions and characteristics are analysed and compared to a real truck. [1] [2] [3] [4]

From the data in Table 1 to Table 5, we can see that the ratio of individual parts of the model truck are not at a constant ratio in comparison to a real truck; to standardise the ratio, a fixed scale of 1: 13.3 is used. In the Tables given below, the columns:

- Real Truck - represents the dimensions of an actual truck and semi-trailer.
- Scaled Real Truck - represents the scaled dimensions of an actual truck and semi-trailer using the scaling ratio of 1:13.3.
- Model Truck - represents the dimensions of the model truck.
- Model-Scaled Real Truck Difference – represents the difference between the dimensions of the scaled real truck from the dimensions of the model truck.
- Ratio – represents the ratio of Real truck: Model truck.

2.1.1 Tractor dimensions

	Real Truck	Scaled Real Truck	Model Truck	Model-Scaled Real Truck Difference	Ratio
Length	5875.0 mm	441.7 mm	458.0 mm	+ 16.3 mm (+ 3.6%)	12.8
Width	2490.0 mm	187.2 mm	187.0 mm	- 0.2 mm (- 0.1%)	13.3
Height	3529.0 mm	265.3 mm	298.0 mm	+ 32.7 mm (+ 12.3%)	11.8
Wheelbase	3600.0 mm	270.7 mm	272.0 mm	+1.3 mm (+ 0.5%)	13.2

Table 1: Tractor dimensions.

2.1.2 Tractor characteristics

	Real Truck	Scaled Real Truck	Model Truck	Model-Scaled Real Truck Difference
Max. Steering Angle	$49°$	$49°$	$26°$	$23°$ (46.9%)
Turning radius	Inner:4110.0 mm	Inner: 309.0 mm	Inner: 600.0 mm	+ 291.0 mm (+94.1%)
	Outer:6600.0 mm	Outer: 496.2mm	Outer: 787.0 mm	+ 290.8 mm (+58.6%)
Weight	6940.0 kg	2.9 kg	4.1 kg	+ 1.2 kg (+41.4%)

Table 2: Tractor characteristics.

2.1.3 Semi-Trailer dimensions

	Real Trailer	Scaled Real Trailer	Model Trailer	Model-Scaled Real Trailer Difference	Ratio
Length	13600 mm	1022.6 mm	985.0 mm	-37.6 mm (- 3.7%)	13.8
Width	2600.0 mm	195.5 mm	195.0 mm	- 0.5 mm (- 0.3%)	13.3
Height (inside trailer)	2470.0 mm	185.7 mm	197.0 mm	+ 11.3 mm (+ 5.7%)	12.5
Height (from ground)	4000.0 mm	300.8 mm	300.0 mm	- 0.8 mm (- 0.3%)	13.3
Weight	6679.0 kg	2.8 kg	5.8 kg	+ 3.0 kg (+ 107.1%)	

Table 3: Semi-Trailer dimensions.

2.1.4 Overall dimensions

	Real Truck with Trailer	Scaled Real Truck with Trailer	Model Truck with Trailer	Model-Scaled Real Truck with Trailer Difference	Ratio
Length	16500.0 mm	1240.6 mm	1240.0 mm	- 0.6 mm (- 0.1%)	13.3
Width	2600.0 mm	195.5 mm	195.0 mm	- 0.5 mm (- 0.3%)	13.3
Height (from ground)	4000.0 mm	300.8 mm	300.0 mm	- 0.8 mm (- 0.3%)	13.3
Fifth Wheel to front of truck			330.0 mm		

Table 4: Overall dimensions.

2.1.5 Tire dimensions

	Real Truck	Scaled Real Truck	Model Truck	Model-Scaled Real Truck Difference	Ratio
Width (front)	315.0 mm	23.7 mm	25.0 mm	+ 1.3 mm (+ 5.5%)	12.6
Width (rear)	315.0 mm	23.7 mm	25.0 mm	+ 1.3 mm (+ 5.5%)	12.6
Width (trailer)	385.0 mm	28.9 mm	25.0 mm	- 3.9 mm (- 13.7 %)	15.4
Radius (steer tire)	537.8mm	40.4 mm	41.5 mm	+ 1.1 mm (+ 2.7%)	13.0
Radius (rear tire)	537.8mm	40.4 mm	41.5 mm	+ 1.1 mm (+ 2.7%)	13.0
Radius (trailer tire)	536.0 mm	40.3 mm	41.5 mm	+ 1.2 mm (+ 3.0%)	12.9

Table 5: Tire dimensions.

Data from Table 2 shows the steering angle of the model truck is significantly smaller than in a real truck thus limiting the turning radius of the model truck. Also, the weight of the model truck is scaled down a factor of 13.3^3, since all 3 dimensions of the truck need to be considered.

Data from Table 4 is of particular importance as it gives an overall mapping of the model truck to a real truck, the length, width and height of the model are very similar to that of a real truck.
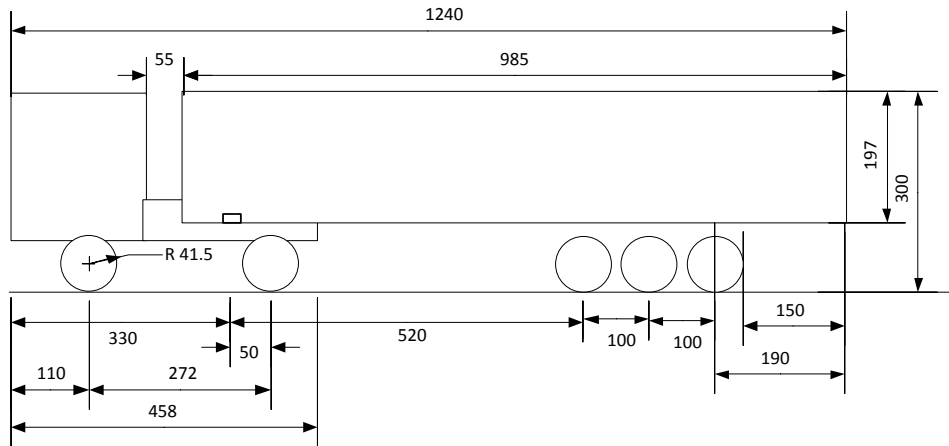
2.2 Model truck drawings

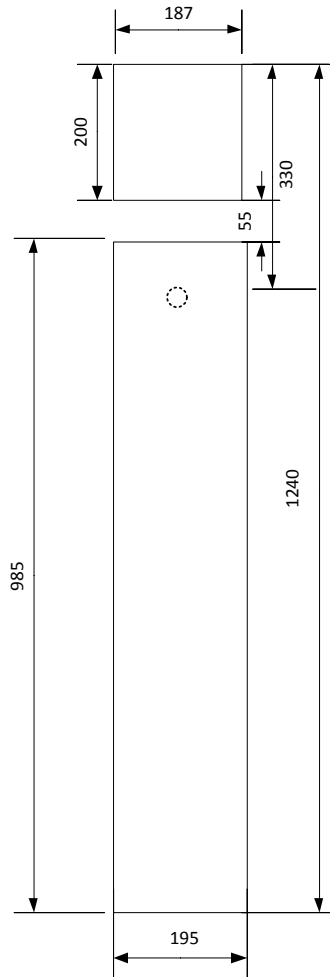*Figure 2: Side view of the model truck with trailer.*

Figure 3: Top view of model truck with trailer.

3. Controlling the Model Truck

In this section of the report, we shall firstly investigate the RC communication of the model truck. On understanding the original setup, an Olimex E407 microcontroller with Simulink is used to replace the existing transmitter-receiver system. Next, control of the model truck using a PC and a Logitech gaming steering wheel is described. Finally, the model truck is tested to explore the repeatability of the path taken for pre-defined inputs.

3.1 Understanding the original RC setup

In order to obtain an overview of the RC setup, Figure 4 shows a comparison between the existing RC setup and the new setup. The hardware changes require the elimination of the RC transmitter-receiver, these are replaced with a PC and an Olimex-E407, using a WiFi for transmitting and receiving the data respectively. While the original RC setup has no software in it, the new setup uses MATLAB/Simulink with HANcoder. As seen in figure 4, the Simulink section consists of two modules wherein, one module is uploaded to the microcontroller which, is located in the model truck, while the other module is on the PC. The HANcoder software enables the use of Simulink models on the Olimex E407.
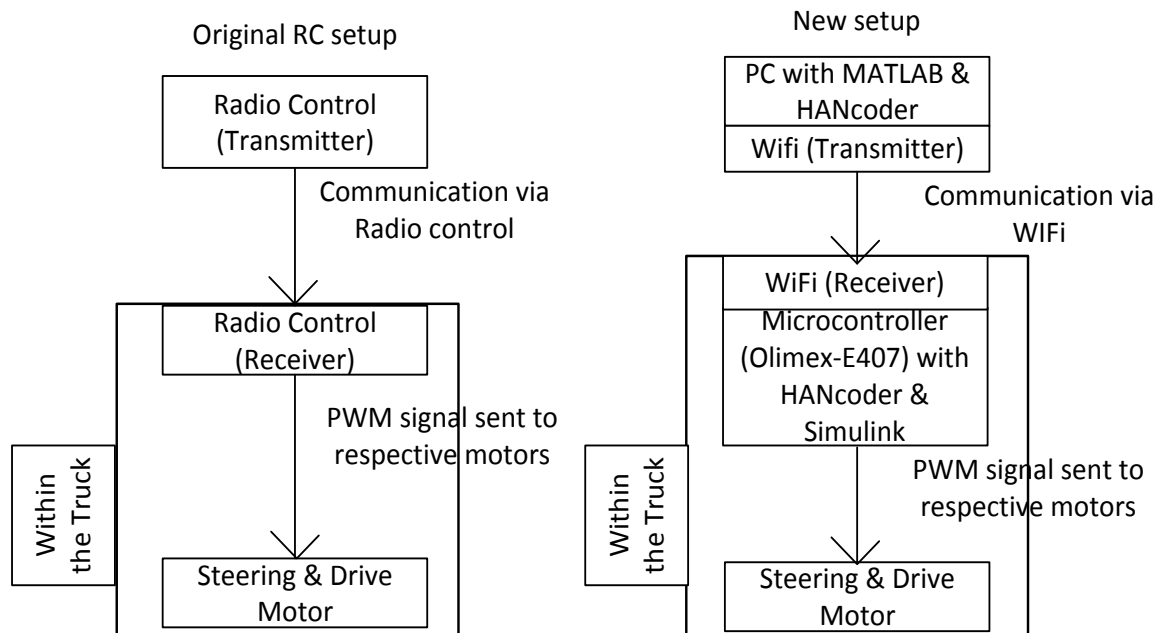

Figure 4: Overview of the Original RC setup vs New setup.

By investigating how the transmitter-receiver and communication model works, it was found that the receiver on the truck sends two Pulse Width Modulation (PWM) signals to the steering servo and the drive motors respectively. These actuators convert the PWM signal into a steering position and torque for forward/reverse movement respectively. The PWM signals are transmitted with a frequency of 50 Hz with a width of 1.05 ms to 1.95 ms and a duty cycle of 20 ms. The same parameters work for both motors and Figure 5 shows the signals.
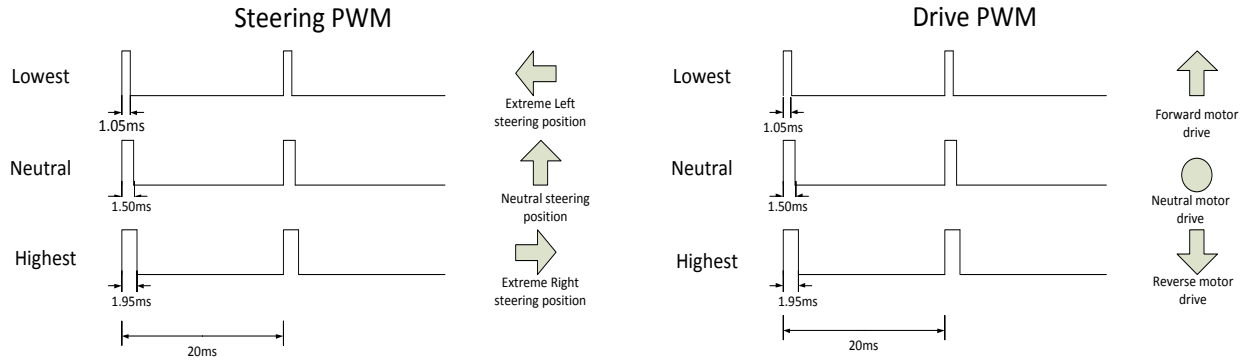
Figure 5: PWM signals for Servo and Drive motors.

To enable the control of the truck using a PC, we use an Olimex E-407 on the model truck along with MATLAB/Simulink and HANcoder; this eliminates the transmitter-receiver system in the original RC setup.

The selected microcontroller can output PWM signals and has an Ethernet port to enable wireless communication with the PC using WiFi. The transmission of PWM value is described by the next equation:

$$\lambda_{PWM} = \frac{t_{signal}}{t_{dutycycle}} . 1024 \qquad\qquad (1)$$

The values obtained for λ_PWM are rounded to whole numbers.

By substituting the values from figure 5 in the formula 1, we see that the PWM range is from 54 to 100 and has a neutral position 77. The values in Table 6 are used in the Simulink bock to control the Servo and Drive motors of the model truck.

λ_{PWM}	Steering PWM	λ_{PWM}	Drive PWM
54	Extreme Left (26°)	54	Forward maximum speed
77	Neutral steer (0°)	77	Neutral
100	Extreme Right (26°)	100	Reverse maximum speed

Table 6: PWM range for Steering and Drive motor input.

3.2 Building a Simulink Model

This section will explain the procedure to build a Simulink block for the PC module and the Olimex E407 module, as shown in Figure 4, with HANcoder.

To ensure Simulink and HANcoder work properly, install the necessary software as listed in Appendix A. Open the Simulink Library browser to build a model. Open the 'HANcoder STM32 Target' toolbox by clicking on it. If the library is not visible try refreshing the library tree view by pressing F5. If this does not work, make sure the 'Current Folder' is set to the 'Target' directory and run "librarySetup.m".

Once the HANcoder toolbox is opened, choose the required blocks from the various categories available in the toolbox. The 'XCP on TCP/IP config' and 'Ethernet config' blocks are used in this case for the flashing of the Olimex E407. Use the help files to determine the proper use of a block. Help is available by right clicking on a block and then selecting "Help". Use of other Simulink blocks in this project are explained in section 3.3 of the report.

The Simulink module for the Olimex E407 is flashed in to the microcontroller. To flash the microcontroller, refer to Appendix D.
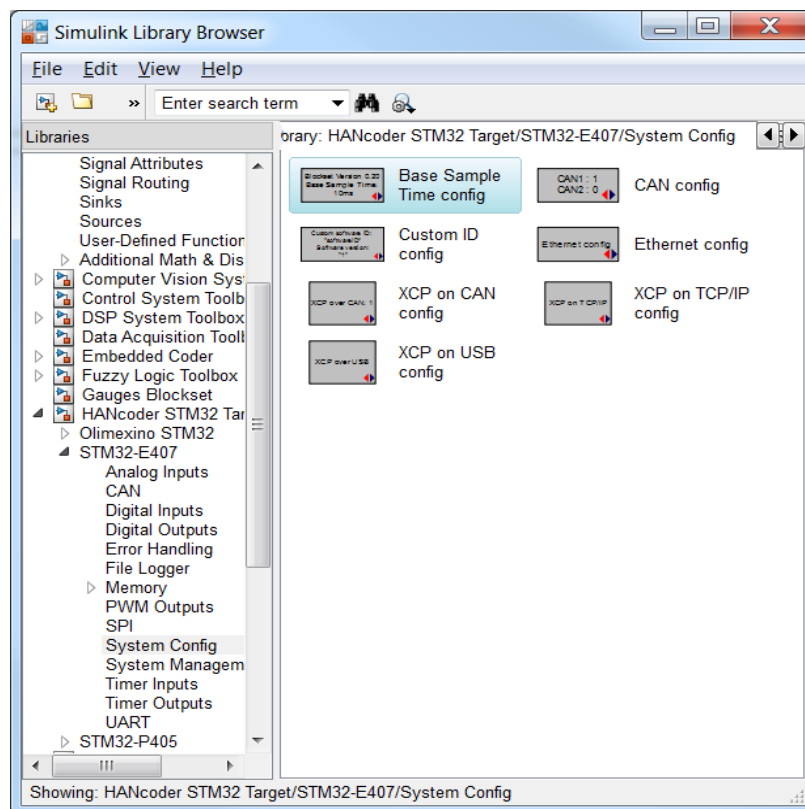

Figure 6: Simulink HANcoder STM32 Target Library.

3.3 Control using PC

A User Datagram Protocol (UDP) data communication is used for getting the set points for the steering and powertrain from the PC using Simulink to the Olimex E407. Two Simulink sections are required:

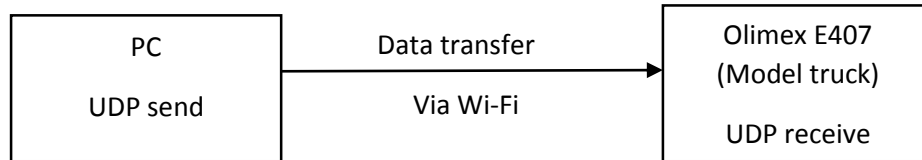1) Simulink module for the PC
2) Simulink module for the Olimex E407

Figure 7: Data transfer between PC and Olimex.

3.3.1 Simulink module for the PC

The model that is used on the PC can be seen as the counterpart of the model running on the Olimex E407. The UDP send block transmits the combined steering and powertrain value to the model truck. This is shown in Figure 8. The UDP send block is initialized to send via port 2048 to IP 169.254.19.63 which belongs to the Olimex E407.
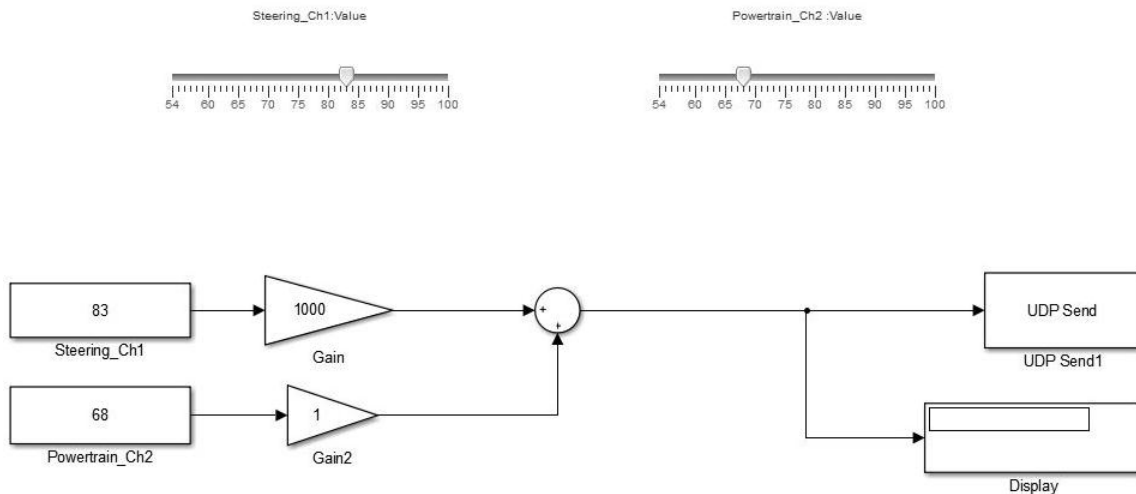

Figure 8: Simulink PC.

This data transfer algorithm is chosen, since we are able to send only 1 signal at a time using the UPD send block. However 2 signals, 1 for Steering and 1 for Powertrain should be transmitted. The steering and drive motor set points are combined to form one signal. The steering PWM value is multiplied by 1000 and added to the powertrain PWM value, thus combining the 2 values to 1 signal. For example 83*1000 + 68 = 83068. This value can then be read at the receiving end and interpreted as shown in Figure 10.

3.3.2 Simulink module for the Olimex E407

The Simulink module used for the Olimex E407 consists of a UDP receive block and a PWM init block. The PWM init block is used for selecting the active pins and the frequency of the PWM signals to be used with the Olimex E407. The frequency is set to 50 Hz and the pins used on the Olimex E407 will be PE5 and PE6. A description of the pins used on the Olimex E407 can be found the Appendix F.

The UDP receive Simulink block is shown in figure 10. Dividing the signal obtained at the UDP receive by 1000 using the example value of 83068 gives an integer value corresponding to the steering value of 83 without decimation, this can be obtained by changing the rounding in the 'Gain' block in Simulink. Next, the steering value is multiplied by 1000 again giving 83000 and subtracting 83000 from the original signal value which is 83068 gives the drive motor value of 68. The range for the PWM signal is 0-1023. However, the range used for the model truck is from 54 -100, since only a small part of global PWM range is used, the resolution of the servo and drive motors is not high.

The Simulink model built for the Olimex E407 is flashed using microboot. The microboot is a software that enables communication and transfer of data between the Olimex E407 and the PC. More details about the microboot can be found in Appendix D.
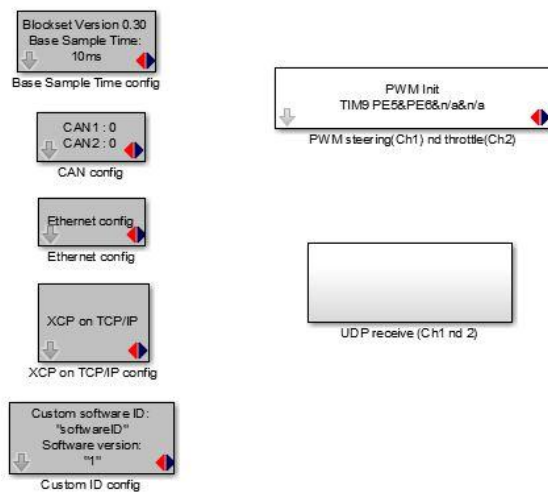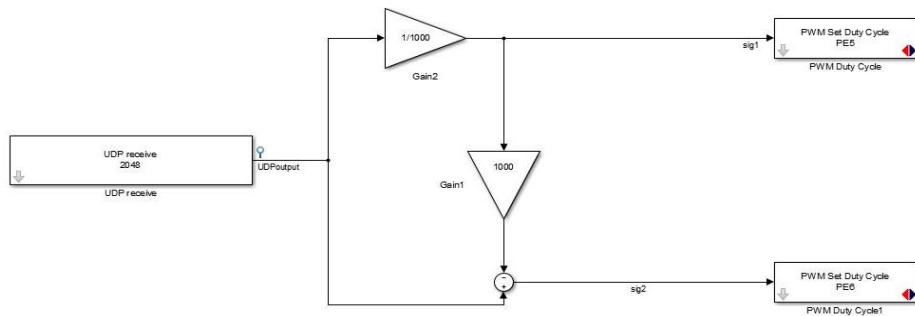

Figure 9: Simulink module for the Olimex.

Figure 10: Simulink UDP receive subsystem in the Olimex.

3.4 Control using gaming wheel system

A Logitech gaming steering wheel is used for the manual control of the model truck and is shown in Figure 11. The gaming steering wheel system is connected to the PC via USB.
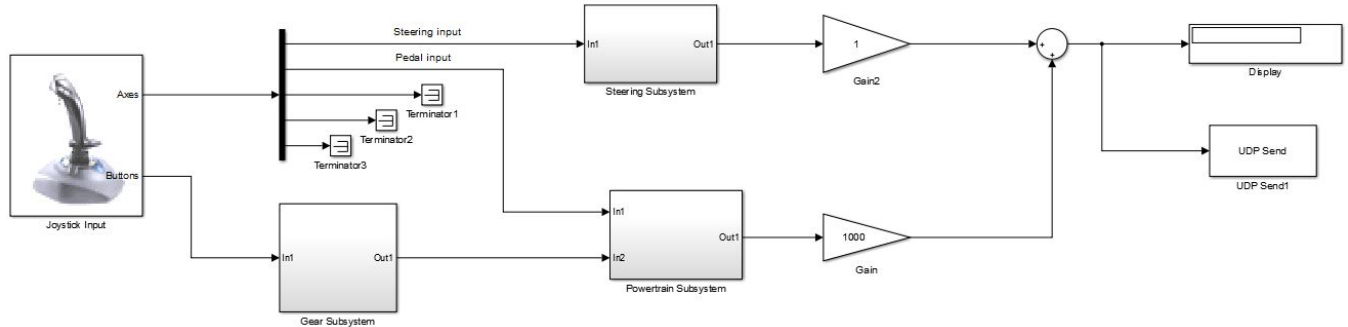

Figure 11: Logitech G27 gaming steering wheel.

Figure 12: Simulink Model Truck Control System.

The input given by the steering wheel and pedals can be included in a Simulink model using a "Joystick" input block.

Figure 12 shows the Simulink model including the joystick block which enables the use of the gaming wheel, gear lever and pedals. The subsystems within the block are shown in Figure 13, Figure 14 and Figure 15.
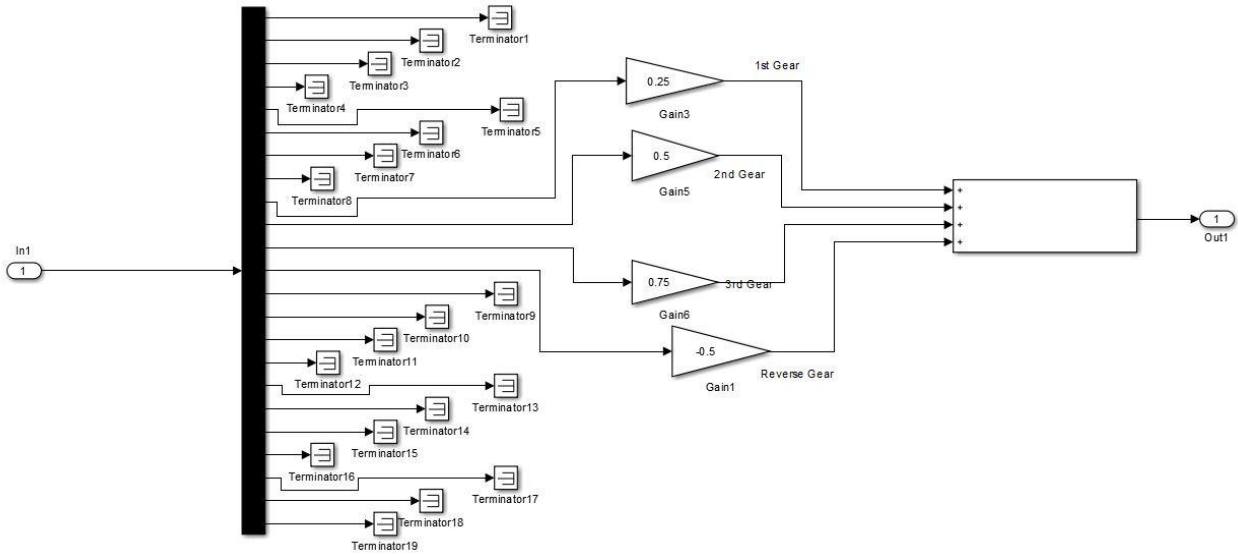
Figure 13: Simulink Gear Subsystem.

The Gear subsystem shown in Figure 13 can be used to limit the maximum speed of the powertrain for the model truck. Gears 1, 2 & 3 limit the model truck to travel at 25%, 50% and 75% of the maximum speed of the model truck. Gear 4 is used to enable the model truck to move in reverse. As a safety measure, the truck is not allowed to travel at 100% of the maximum speed since this is very fast. If needed this can be added the gear subsystem. In Figure 13, input 1 is from the gear lever. Based on the gear selected, the corresponding gear receives a multiplying factor of 1 at the 'demux' block while the other gears receive a multiplying factor of 0. Output 1 goes to the accelerator pedal subsystem.
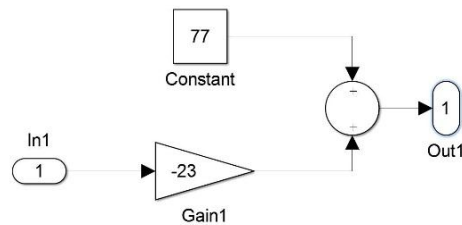

Figure 14: Simulink Steering Subsystem.

As discussed in section 3.1, the zero steer angle is obtained for a PWM value of 77 and the range is +23 for maximum right steer while -23 is maximum left steer. The steering subsystem multiplies the value form the steering wheel which ranges from -1 to 1 with -23 to obtain the final steering angle. In Figure 14, input 1 comes from the steering wheel and output 1 goes to a 'gain' block which ultimately is used as a part of the UDP send.
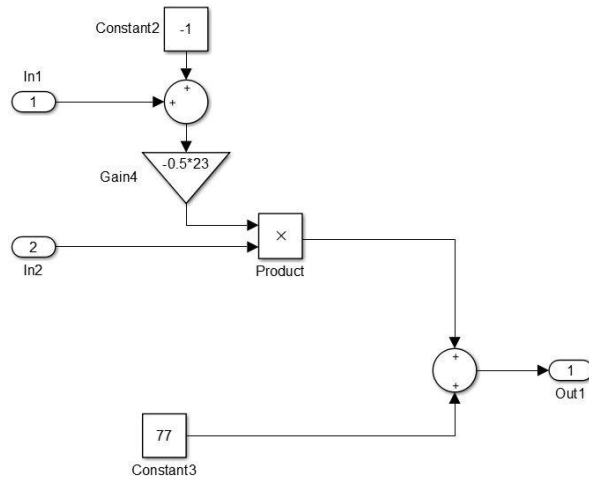
Figure 15: Simulink Accelerator pedal Subsystem.

The accelerator pedal subsystem shown in Figure 15 can be used to control the speed of the model truck from the lowest speed to the maximum speed for a selected gear input from the gear subsystem. Input 1 in Figure 15 is the accelerator pedal from the gaming wheel system which ranges from 1 to -1 which is multiplied with 23 to obtain the drive motor input. Input 2 in Figure 15 comes from the gear subsystem and is used as a multiplier to control the maximum overall speed of the model truck. The combination of input 1 and input 2 gives the PWM value to the drive motors of the model truck. Output 1 goes to a 'gain' block and is ultimately used to complete the data that is sent to the 'UDP send' block.

3.5 Path followed for pre-defined input data

In order to show demos for autonomous movement for a pre-defined path, the Simulink model from section 3.4 is modified to record the input given to the truck during manual control, as shown in figure 16. The input provided by the user using the gaming steering wheel system is saved in a "to file" block.
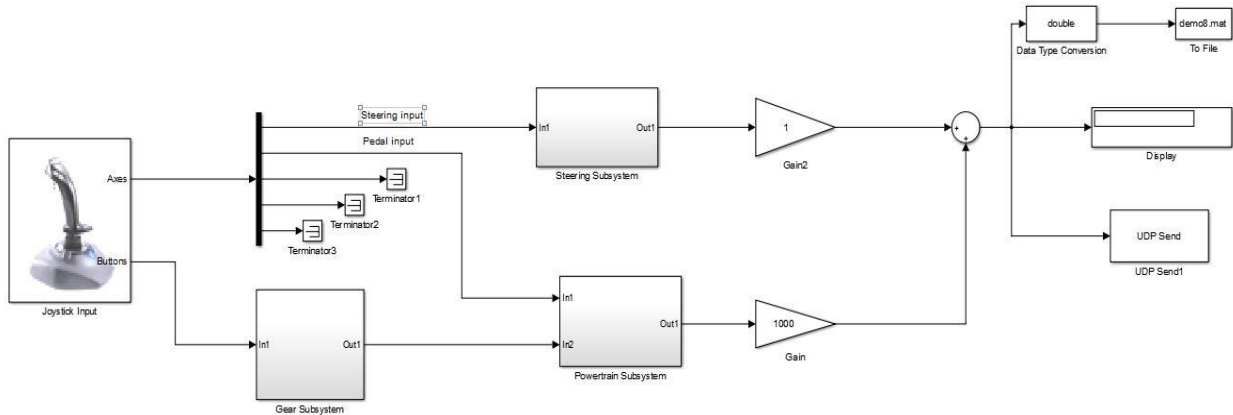

Figure 16: Simulink block for recording manual input.

To redo this manoeuvre, the signal saved to the "to file" block from Figure 16 can be sent to the "UDP send" block as shown in Figure 17 using a "from file" block.
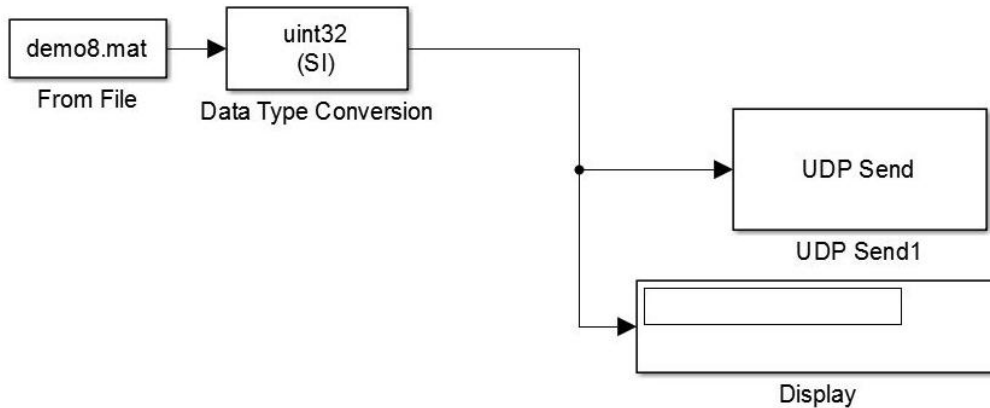

Figure 17: Simulink Autonomous Demo.

To determine the accuracy of the autonomous movement using the pre-defined input, a manoeuvre in the figure of "8" was performed and recorded. An approximate grid like setup was used as a reference to indicate the initial and final positions of the model truck for the test. Figure 18 shows the initial staring position for the manual input and autonomous movement.

Figure 18: Initial position of the model truck.

Figure 19 shows the final position of the model truck while giving manual input and Figure 20 shows the final position of the model truck while using the pre-defined data input, which is the same data as used for the manual input.

Figure 19: Final position of the model truck using manual input.

Figure 20: Final position of the model truck using pre-defined input.

Comparing the final position of the model truck from Figure 19 and Figure 20, it is evident that the model truck is not accurate in autonomously reproducing the same path when compared to the manual input.

One of the reasons for this could be due to the poor resolution of the steering and drive motor input as mentioned in section 3.3.2. This could be overcome with the use of various sensors to create a feedback system.

4. Conclusion & Recommendations

The model truck was originally scaled at a ratio of 1:14, however, after analysing the model the scaling factor was changed to 1:13.3.

The model truck with the original transmitter-receiver setup was analysed, which allows the necessary modifications to be made to achieve the objective: being able to drive the model truck with a gaming steering wheel.

In order to try and go a step beyond in the open-loop setup, the autonomous demo was tested. However, despite taking high sampling frequency, the path followed while manually controlling and pre-defined input show different paths being taken by the model truck. This can be corrected by the use of various sensors, such as encoders, to provide truck and wheel position feedback.

Some of the difficulties faced during the project were:

1) The surface of the lab is relatively smooth resulting in slip of the wheels on the driven rear axle. Tests need to be done to find a suitable surface to reduce tire slip, an alternative is to increase the load on the rear tyres.

2) The Olimex E407 is currently located in the semi-trailer, which does not allow the use of the tractor individually. Modifications to the cabin can be made to change the tilting mechanism to a lifting mechanism to accommodate the E407 within the cabin, giving the user the flexibility to use the tractor without the semi-trailer.

3) The maximum steering angle in the current model is $26°$ whereas for a real truck the maximum steering angle is greater than $49°$. Modifications to the steering system and servos controlling the steering input may have to be made to match a more realistic $49°$.

4) Due to lack of easy access to the batteries, the model truck has to be flipped sideways to charge the batteries. An alternate location to access the batteries or an external connector has to be made to avoid damaging the model by accident.

5) For every new Olimex E407, a J-tag needs to be used to initialize the ports on the board the first time. Proper understanding of the use of J-tag to enable the ports such as the LAN port is yet to be achieved.

Open-loop Control of the model truck with MATLAB/Simulink has been achieved. For the next phase of the project, to realize a more accurate path tracking for auto docking, cameras will be used to locate the vehicle and to determine its position.

Appendix A – Software Requirements

- MATLAB (2009a or higher)
- HANcoder v0.5
- GNU ARM Toolchain [5]: Choose the following file: 'gcc-arm-none-eabi-5_4-2016q2-20160622-win32.exe'

Please refer to the **Getting started with Olimex** report provided by HAN [6] for installation of the required software.

Appendix B – Hardware Used

The hardware used mainly comprise of

1) Truck parts:

- Tamiya 30056329N MAN TGX 18.540 4x2 XLX 1:14 Electric RC model truck Kit - http://www.conrad.com/ce/en/product/1326007/Tamiya-30056329N-MAN-TGX-18540-4x2-XLX-114-Electric-RC-model-truck-Kit?ref=list
- Carson 907080 1:14 RC Canvas Cover Semi Trailer - http://www.conrad.com/ce/en/product/235138/Carson-907080-114-RC-Canvas-Cover-Semi-Trailer-L-x-W-x-H-900-x-195-x-290-mm?ref=list
- Bluebird BMS-620 MG Double ball bearing drive Metal JR - http://www.conrad.com/ce/en/product/275463/Bluebird----BMS-620-MG-Double-ball-bearing-drive-Metal-JR
- Graupner Standard servo Digital servo Gear box material: Metal Connector system: JR - http://www.conrad.com/ce/en/product/208122/Graupner-Standard-servo-Digital-servo-Gear-box-material-Metal-Connector-system-JR
- Reely Standard servo RS-303 Analogue servo Gear box material: Plastic Connector system: JR - http://www.conrad.com/ce/en/product/1365922/Reely-Standard-servo-RS-303-Analogue-servo-Gear-box-material-Plastic-Connector-system-JR

2) Controller (E407) parts:

- PCB design board Olimex STM32-E407 - http://www.conrad.com/ce/en/product/1195103/PCB-design-board-Olimex-STM32-E407?queryFromSuggest=true
- TP-LINK TL-WR802N WLAN router 2.4 GHz 300 Mbit/s- http://www.conrad.com/ce/en/product/1368688/TP-LINK-TL-WR802N-WLAN-router-24-GHz-300-Mbits?ref=searchDetail
- Logitech G27 Racing wheel - http://gaming.logitech.com/en-hk/product/g27-racing-wheel

Appendix C - Info & setup of mini Wi-Fi router

Model: TL-WR702N 150Mbps Wireless N Nano Router

Figure 21: TP Link Mini router.

Specifications

The specifications can be found on the website:
http://www.tp-link.com/en/products/details/cat-9_TL-WR702N.html#specifications

How to configure as an access point

- Connect the cable to power supply
- Connect the ethernet cable
- Open the PC Control Panel – Network Connection – Local Connection – Properties – Protocol TCP/IP V4 – Manual IP: 192.168.0.10, Mask: 255.255.255.0 (default), Gateway: 192.168.0.254 – OK
- Open browser – enter the gateway address – usually the user name and password is "admin".
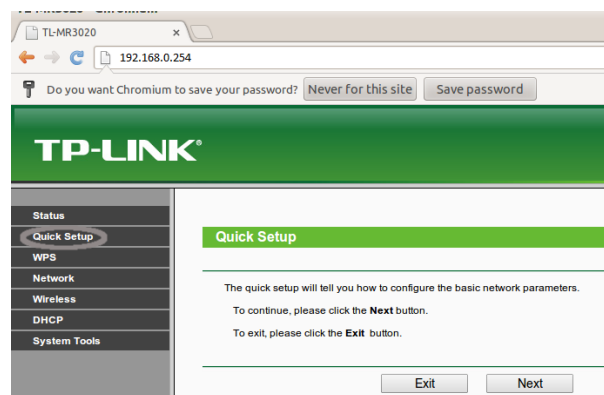
Figure 22: TP Link setup page.

- Quick setup - AP – Survey – define a name and password to your network – connect – country – next – reboot
- Network connection –TCP/IP v4 – obtain IP automatically
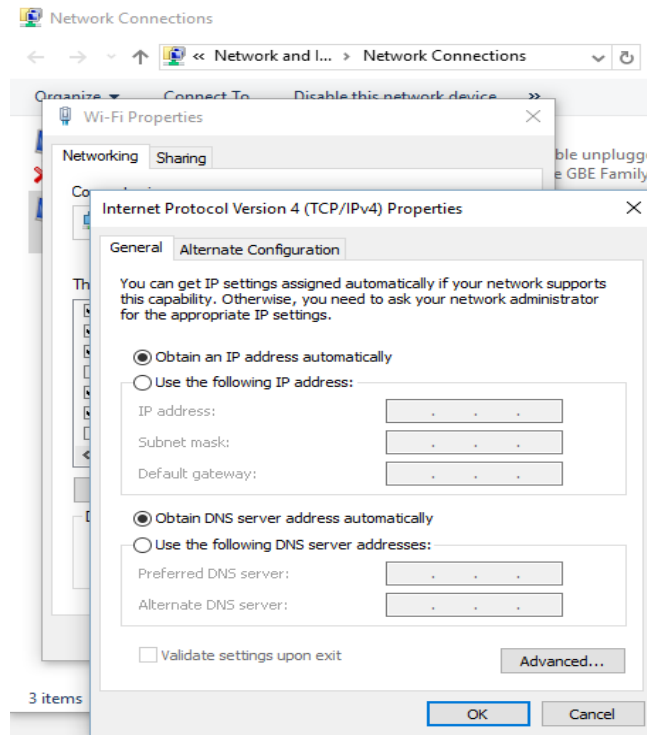
Figure 23: TP Link IP address tab.

- Check if the network is working by verifying the PC is connected to the router after disconnecting the Ethernet cable and establishing connection via WiFi.

Once this setup has been completed and the WiFi connection has been established, the router is connected to the E407 via Ethernet cable to the Ethernet port on the Olimex E407.

Appendix D – Flashing the E407

The process of uploading the Simulink block to the E407 is called flashing and it needs to be performed every time a new/modified Simulink block is to be used.

Setting up the Simulink block for flashing

Before the software program can be flashed via TCP/IP, the Olimex E407 needs some reconfiguration to reserve space for the bootloader.

This reconfiguration step can be performed entirely in the Simulink model described in Chapter 3.2. Open the Simulink and Select *Simulation -> Model Configuration Parameters…* from the taskbar at the top.
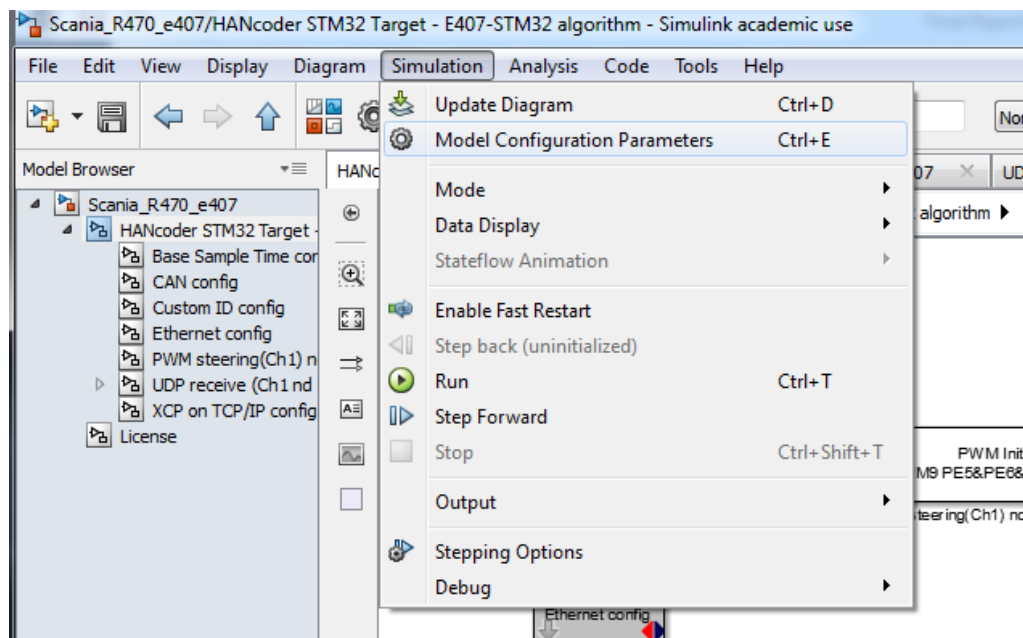
Figure 24: Olimex Simulink tab.

In the Real-Time Workshop configuration screen, check if "HANcoder_BOOTLOADER=1" is present in the *Make command* and click OK, see Figure 22.

Now generate the code and build the model, the software should be properly configured for use with the bootloader.
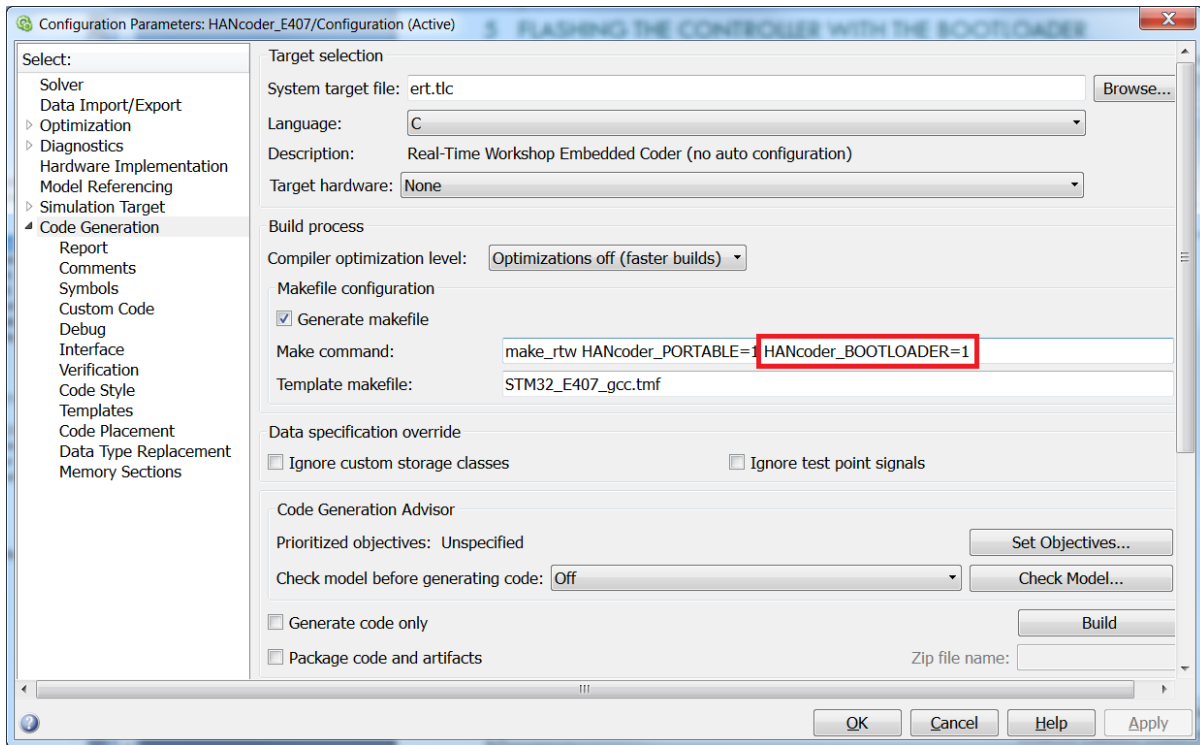
Figure 25: Olimex configuration parameter tab.

Flashing the Olimex E407 via TCP/IP

- Connect the Olimex E407 and PC using an ethernet cable and power up the Olimex E407.
- Check if the settings are correct – Open the command prompt and run the command 'ping 169.254.19.63'. It should answer like the figure below:

Figure 26: Command prompt to verify connection between Olimex and PC.

- The MicroBoot utility is used to select the file to be uploaded to the Olimex E407. Start the MicroBoot utility on the PC. It can be found in '\HANcoder\MicroBoot\MicroBoot.exe'.
- Click the *Settings*-button and select 'OpenBLT using TCP/IP' if this one was not already active, and click the *OK*-button to save the settings. The setting is changed to ensure the right mode of communication between the Microboot and the Olimex E407 is selected.
- Next, click the *Browse*-button to select the .slx/.srec file of your software program. The demo model is located at '\Target\HANcoder_E407.srec'.
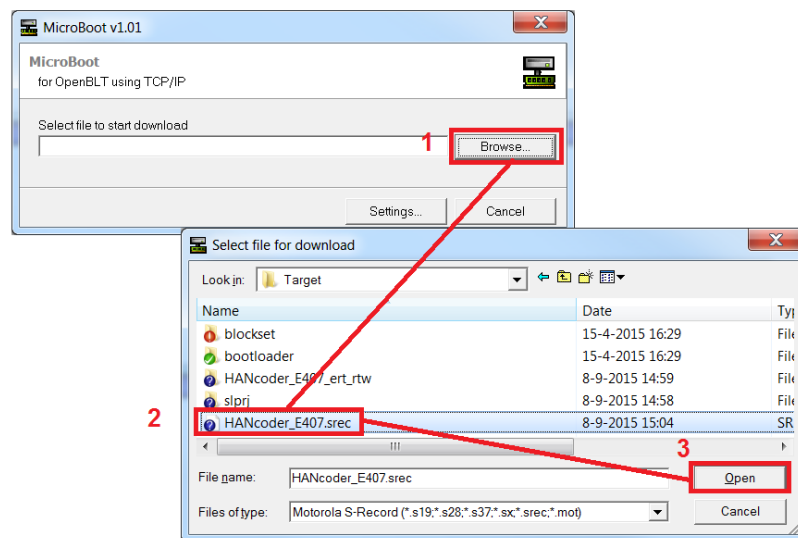

Figure 27: Microboot Simulink file selection.

- The firmware update with the bootloader is now started. If a user program is currently running, Microboot will not get a response from the target. In this case Microboot will display the following info:
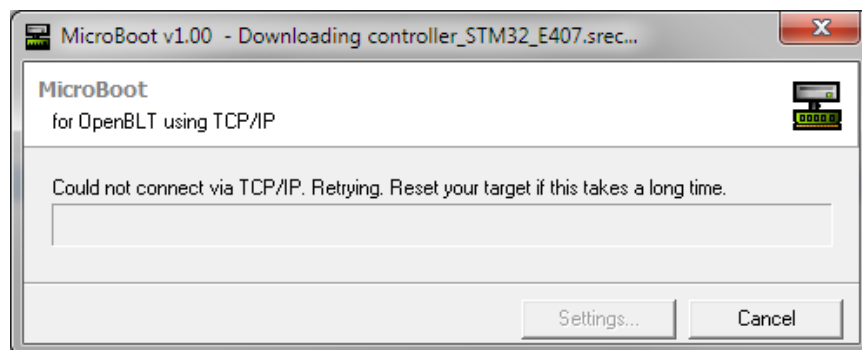

Figure 28: Microboot Simulink file upload error tab.

- In this case press and release the reset button on the Olimex E407. This will activate the bootloader. After a few seconds the actual firmware update will start. Once completed, your newly flashed software program is automatically started.
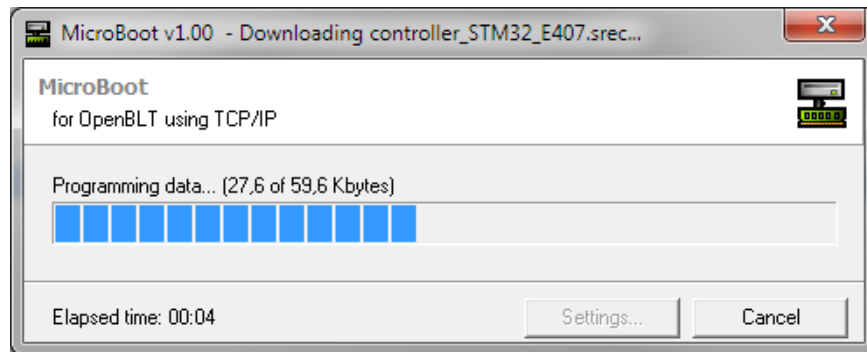

Figure 29: Microboot Simulink file upload tab.

Please note that there may be a delay of several seconds before the newly programmed application is started. This is because after reset, the bootloader must stay active long enough for the TCP/IP stack to initialize and establish a link so it can receive a firmware update request from Microboot.

Appendix E - Configuring PC communication with E-407 over Ethernet

The default Ethernet address for the bootloader is: 169.254.19.63. The IP address for HANcoder can be chosen in the "Ethernet config" block in Simulink. If there are more than one Olimex E407 board in use, then the IP address 169.254.19.XX can be used, with changes to the last 2 digits alone

- Connect the E407 and PC using an Ethernet cable
- Open the 'Network and Sharing Center' by clicking the 'View network status and tasks' in the Control Panel.
- Click on the 'Local Area Connection'
- Go to Properties and select the 'Internet Protocol Version4(TCP/IPv4)' and click on properties once again
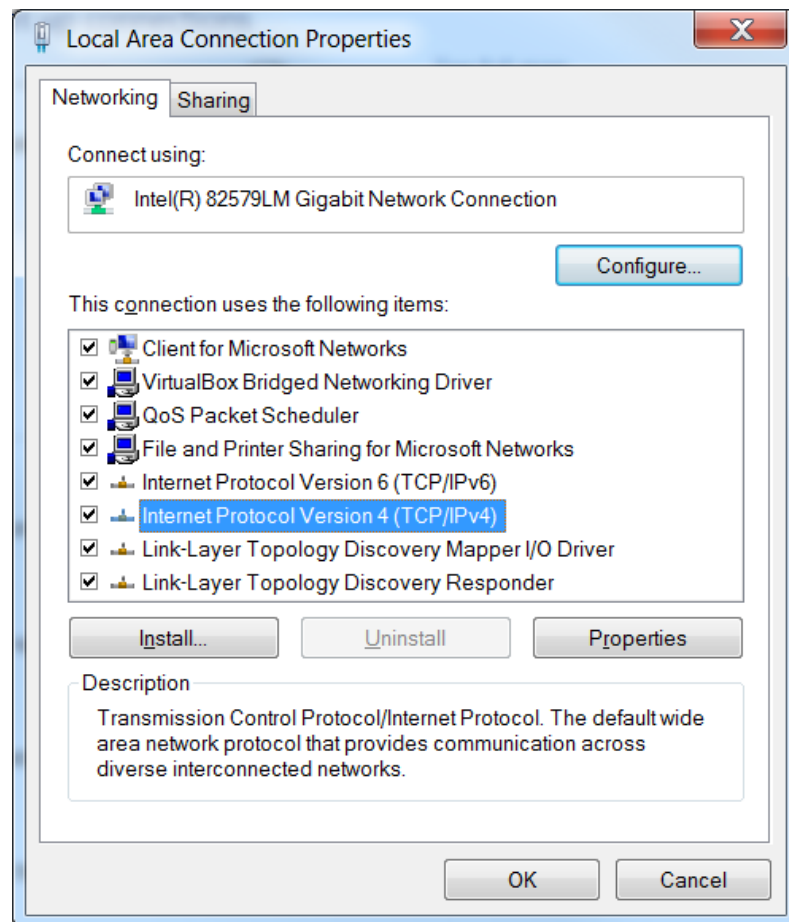

Figure 30: PC Local area connection tab.

- Adjust the IP address to 169.254.19.XX where the last 2 digits are close to the address of the E407 but not the same address. The IP address used in the PC now is 169.254.19.64. Adjust the Subnet mask to match the subnet mask in the settings of the E407. Leave the Default gateway and DNS settings open. See following screen:
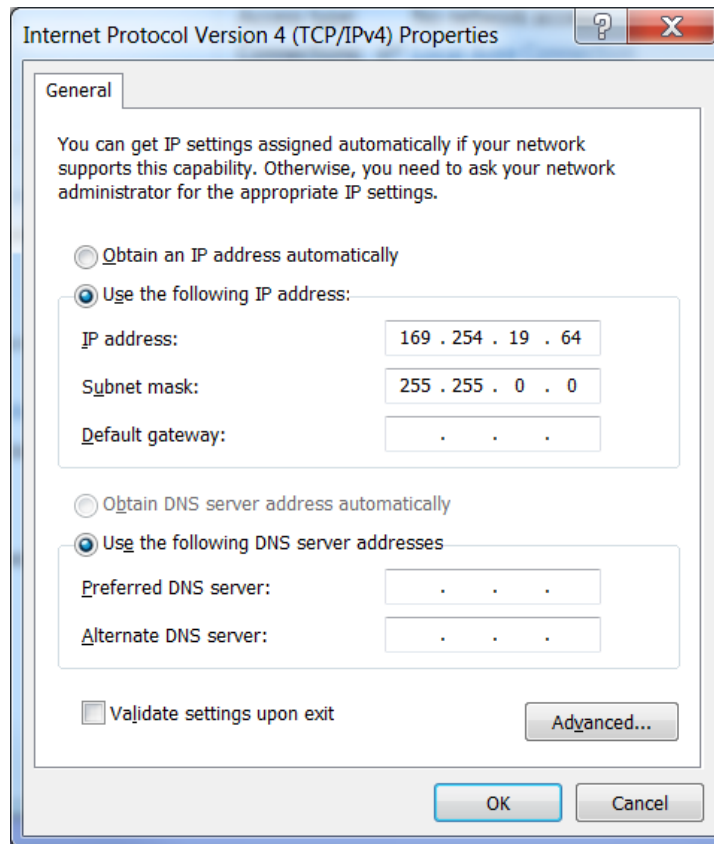

Figure 31: PC IP address tab.

- Your connection should now work. You can test the connection by pinging the Olimex E407 as described Appendix D.

Appendix F - Connections on the Olimex E407

The Olimex E407 board is split into 4 sections, PD, PE, PF and PG. Pins PE5 for steering servo motor and PE6 for drive motor are used which are in the PE section of the board where,
PE5 corresponds to pin number 8 on PE
PE6 corresponds to pin number 9 on PE

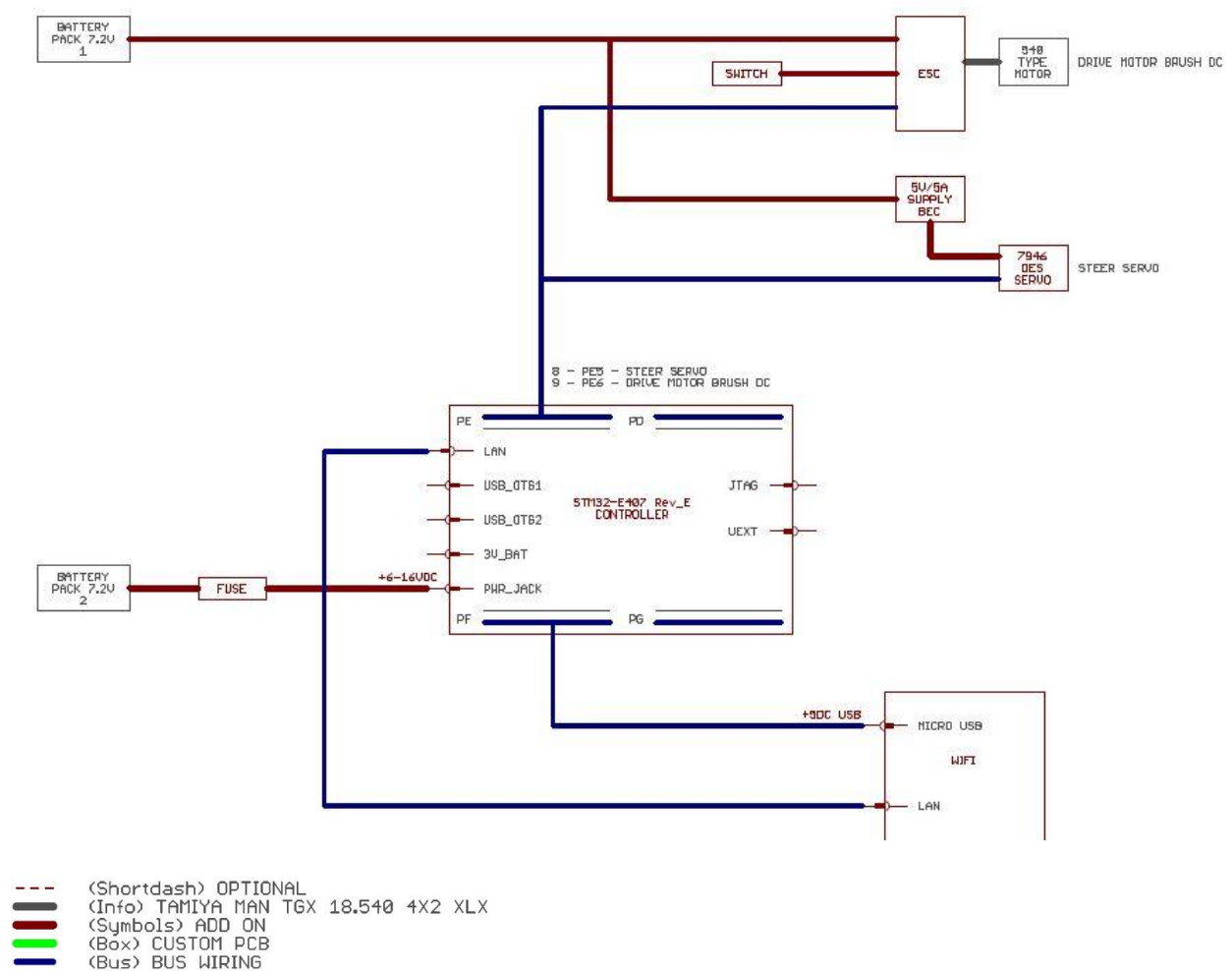The ESC is an electric motor controller which is capable of controlling up to 2 motors at a time.

Figure 32: Olimex E407 electrical connection configuration.

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