Vehicle Intersection Control

McMaster University

Verification and Validation

SE 4G06

Group 6

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1 Revisions

Table 1: VIC Table of Revisions

Date	Revision Number	Authors	Comments
February 27, 2017	Revision 0	Alex Jackson Jean Lucas Ferreira Justin Kapinski Mathew Hobers Radhika Sharma Zachary Bazen	N/A

2 Purpose

The purpose of this document is to examine the previous project goals and requirements, and to see how the end system complies with these requirements. Through validation, it will determined if the project goals were met. Verification will allow for the detection of errors, and build a level of confidence in the system.

This document will include a traceability matrix to map the test cases to the functional requirements. Further more, the test cases will be presented along with a code walk-through, and static analysis.

The intended audience for this document consists of Dr. Alan Wassyng and the course's teaching assistants.

3 Validation

3.1 Project Goals and Functional Validation

The system consists of two main components: Vehicle Controller and Intersection Controller. Each component of the system has its own specific goals. By integrating these component-specific goals with our functional requirements, the entire project goals are realized. Therefore, if we can validate that our system components meet our functional requirements, we can assert that they fulfill our project goals.

Table 2: Vehicle Controller Component Goals

Component Name	**Goals**	**Functional Requirement**
Image Processing	- Detect lanes, obstacles, and the intersection	V2, V3, V5, V6
Vehicle Navigation	- Guide the vehicle movements on the track - Stop the vehicle when necessary	V2, V4, V5, V6
Communication	- Send request messages to the Intersection Controller - Receive response messages from the Intersection Controller	V1
Servo Motor	- Set the desired angle of the wheels	V2, V5, V6
Speed Controller	- Set the desired speed of the vehicle	V2, V4, V5, V6

Table 3: Intersection Controller Component Goals

Component Name	**Goals**	**Functional Requirement**
Vehicle Detection	- Detect location of cars and obstacles present at the intersection	IC1, IC3
Communication	- Receive request messages from the Vehicle Controller - Send response messages to the Vehicle Controller	IC5
Intersection Management	- Control the traffic flow of the intersection	IC4

4 Traceability Matrix

Identifier	Reqs Tested	V1	V2	V3	V4	V5	V6	V7	IC1	IC2	IC3	IC4	IC5
Test Cases	13	4	##	##	##	##	##	##	##	##	##	2	13
HC1.1	#												
HC1.2	#												
HC1.N	#												
HC2.N	#												
IC1.1	2	X											X
IC1.2	3	X										X	X
IC1.3	1												X
IC1.4	2	X											X
IC1.5	1	X											
IC2.1	1												X
IC2.2	2											X	X
IC2.3	1												X
IC2.4	1												X
IC2.5	1												X
IC3.1	1												X
IC3.2	1												X
IC3.3	1												X

Identifier	Reqs Tested	V1	V2	V3	V4	V5	V6	V7	IC1	IC2	IC3	IC4	IC5

5 Verification

5.1 Hardware Verification

5.1.1 Individual Vehicle Hardware Component Verification

4.1.1.1 Servo Verification

Test ID	Requirement ID	Description	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
HC1.1	V2, V5, V6	- Description	- input 1 - input 2 etc.	- Behaviour stuff goes here. Some more stuff	- Actual stuff goes here. Some more stuff	Pass
HC1.2		<Text Here>	<Text Here>	<Text Here>	<Text Here>	-
HC1.3						-
HC1.4						-

4.1.1.2 Component 2 Verification

Test ID	Requirement ID	Description	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
HC2.1	#	testing testing testing testing testing testing testing testing testing testing testing testing testing testing testing	- input 1 - input 2 etc.	- Behaviour stuff goes here. Some more stuff	- Actual stuff goes here. Some more stuff	Pass
HC2.2			<Text Here>	<Text Here>	<Text Here>	-
HC2.3						-
HC2.4						-

4.1.1.3 Component 1 Verification

Test ID	Requirement ID	Description	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
HC3.1	#	- Description	- input 1 - input 2 etc.	- Behaviour stuff goes here. Some more stuff	- Actual stuff goes here. Some more stuff	Pass
HC3.2		<Text Here>	<Text Here>	<Text Here>	<Text Here>	-
HC3.3						-
HC3.4						-

5.1.2 Integrated Vehicle Hardware Component Verification

4.1.2.1 Integrated Verification

Test ID	Requirement ID	Description	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
IHC1.1	#	- Description	- input 1 - input 2 etc.	- Behaviour stuff goes here. Some more stuff	- Actual stuff goes here. Some more stuff	Pass
IHC1.2		<Text Here>	<Text Here>	<Text Here>	<Text Here>	-
IHC1.3						-
IHC1.4						-

5.2 Software Verification

5.2.1 Vehicle Software Verification

4.2.1.1 <Module Name>

Test ID	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
VSC1.1	- input 1 - input 2 etc.	- Behaviour stuff goes here. Some more stuff	- Actual stuff goes here. Some more stuff	Pass
VSC1.2	<Text Here>	<Text Here>	<Text Here>	-
VSC1.3				-
VSC1.4				-

4.2.1.2 <Module Name>

Test ID	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
VSC2.1	- input 1 - input 2 etc.	- Behaviour stuff goes here. Some more stuff	- Actual stuff goes here. Some more stuff	Pass
VSC2.2	<Text Here>	<Text Here>	<Text Here>	-
VSC2.3				-
VSC2.4				-

5.2.2 Intersection Controller Software Verification

5.2.2.1 Communication - Recieve

Test ID	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
IC1.1	- Single vehicle intersection request	- Extract request information and put Car object in arrival queue	-	-
IC1.2	- More than 1 vehicle intersection request	- Extract request information and put Car objects in arrival queue in the order that they arrive	-	-
IC1.3	- Vehicle intersection request that is terminated prior to receive completion	- Timeout/ disconnected receive error is caught and system becomes available for subsequent requests		-
IC1.4	- High volume vehicle requests	- Extract request information and put Car objects in arrival queue in the order that they arrive. There is no limitation of buffer size, all completed sent requests should be in arrival buffer.		-

IC1.5	- Invalid message request	- Car objects should only be produced and added to arrival buffer with protocol accepted message contents		-

5.2.2.2 Communication - Send

Test ID	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
IC2.1	- Car object	- Remove vehicle from departure queue and extract proceed destination address and port number. Send proceed message	-	-
IC2.2	- More than 1 car objects	- Remove vehicles from departure queue in FIFO order. Extract individual proceed destination addresses and port numbers. Send proceed messages.	-	-
IC2.3	- High volume vehicle requests	- Should behave as IC3.2 expected behaviour		-
IC2.4	- Send to inactive connection	- Inactive connection error should be caught. The system should then attempt to send the message again (up to the maximum attempt limit)		-
IC2.5	- Connection terminated prior to send completion	- Timeout/ disconnected send error should be caught. The system should then attempt to send the message again (up to the maximum attempt limit)		-

5.2.2.3 Communication - Message Extraction

Test ID	Input	Expected Values	Actual Values	Pass/Fail
IC3.1	2, 'Red', 'Blue'	Car(bluetooth Address, 1, 'Red', 'Blue')		-
IC3.2	2, 'Red', 'Red'	Incorrect Message contents		-
IC3.3	-, 'Yellow', 'Green'	Incorrect Message contents		-

5.2.2.4 ImageProcessing

Test ID	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
IC4.1	-	-	-	-
IC4.2	<Text Here>	<Text Here>	<Text Here>	-
IC4.3				-
IC4.4				-

5.2.3 Integrated Vehicle Intersection Software Verification

5.2.3.1

Test ID	Input	Expected Behaviour	Actual Behaviour	Pass/Fail
VIC.1	- Single vehicle, clear intersection	- Vehicle proceeds directly through the intersection	-	-
VIC.2	- Single vehicle, obstacle in intersection	- Vehicle should stop at the intersection		-
VIC.3	- Single vehicle, intersection controller system not working	- Vehicle should stop at the intersection and wait		-
VIC.4				-
VIC.5	- Multiple vehicles, parallel directions, clear intersection	- Vehicles proceed directly through the intersection		-
VIC.6	- Vehicle A and Vehicle B, crossing directions, clear intersection, Vehicle A is first	- Vehicles A proceeds directly through the intersection, Vehicle B stops at the intersection		-
VIC.7	- Multiple vehicles, obstacle in intersection	- Vehicles should stop at the intersection		-
VIC.8	- Multiple vehicles, intersection controller not working	- Vehicles should stop at the intersection and wait		
VIC.9	-	-		-
VIC.10	-	-		