



Vehicle Intersection Control

McMASTER UNIVERSITY

Hazard Analysis

SE 4G06

GROUP 6

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1 Revisions

Table 1: VIC Table of Revisions

Date	Revision Number	Authors	Comments
January 9, 2017	Revision 0	Alex Jackson Jean Lucas Ferreira Justin Kapinski Mathew Hober Radhika Sharma Zachary Bazen	N/A

2 Introduction

When multiple autonomous cars arrive at an intersection simultaneously, due to the lack of a decision making protocol, the cars have no way of determining in which order to proceed. The purpose of this project will be create a system that allows autonomous cars to navigate through intersections. This will be accomplished by providing an appropriate order for the vehicles to proceed through the intersection.

Vehicle Intersection Control (also known as VIC) will allow autonomous vehicles to make navigation decisions at intersections. In addition, VIC will be able to dynamically handle changing scenarios at an intersection without running into deadlock or stalemate situations. To ensure safety, VIC will allow cars to navigate through the intersection only after the scheduling algorithm determines the order in which they should proceed.

The following document will outline the hazards that VIC poses to humans, as well hazards to the system. Causes and effect of failures, as well as detection, control and recommended action for failures will also be discussed.

3 Component Descriptions

3.1 Image Processing

This component allows the vehicle to follow lanes and detect obstacles. It makes use of a WebCam, Raspberry Pi, and algorithms to allow the vehicle to interpret the track environment.

3.2 Steering Controller

The steering controller works with the image processing component to steer the vehicle. Further more, the steering controller must make adjustments to ensure the vehicle stays within the track lanes.

3.3 Speed Controller

The speed controller uses a hall effect sensor to determine the speed of the car. This controller will make adjustments to the vehicle's speed according to the track environment.

3.4 Communication

The communication component will consist of the blue-tooth signals between the vehicles and intersection controller. The blue-tooth communication will be utilized by the system to make scheduling decisions.

3.5 Intersection Sensors

The intersection sensors will be used to provide additional feedback to the intersection controller. The sensors will be placed at each lane of the intersection and will signal the intersection controller when a vehicle has arrived or departed from the intersection.

4 FMEA Worksheet

Design component	Failure Modes	Causes of Failure	Effects of Failure	Detection	Controls	Recommended Action
Image Processing	Incorrect Lane Following	Damaged Webcam	Collisions with humans or cars	Visual check	Image processing algorithm must respond within a required time	If too many consecutive deadlines are missed, controller will adjust speed
		Slow feedback	Vehicle exits track	Signal for dead battery	Ensure track is clear and no undesired objects are present	If RaspberryPi battery dies alert the car controller to go in emergency shutdown mode
		Dead Battery	Image processing fails to operate			
	Incorrect Obstacle Detection	Damaged Webcam	Collisions with humans or vehicles	Visual Check	Image processing algorithm must respond within a required time	If too many consecutive deadlines are missed, controller will adjust speed
		Software error		Signal for dead battery	Ensure track is clear and no undesired objects are present	If Raspberry Pi battery dies, alert the car controller to go in emergency shutdown mode
		Slow Feedback				
		loss of power				
Steering Controller	Incorrect Steering	Software Miscalculation	Collisions with human or other cars	Visual Check	Image Processing	Direction corrected with software
		Damaged Servo	Vehicle exits track			Vehicle Shut Down
		Disconnected Wires	Vehicle fails to make turn			Recalibrate/Repair/Replace Servo
		Loose steering assembly				
		loss of power				
Speed Controller	Incorrect Speed	Overheated Speed Controller	Failure to stop at intersection	Hall Effect Sensor	Feedback loop between speed sensor and speed controller	Speed Corrected with software
		Incorrect Speed Calculation	Overshooting lanes when turning	Visual Check		Vehicle Shut Down
		Hall Effect Sensor not working	Damaged hardware			Recalibrate/Repair/Replace Speed Sensor and/or Speed Controller
		Motor Failure	vehicle Instability			
		Disconnected wires	Collision with vehicle or cars			
		loss of power				
Communication	Failure to maintain signal	Low signal	Vehicle waits too long at intersection	Intersection Sensors will detect car at intersection		Refresh/Reconnect
		Car distance out of range	Vehicle goes through intersection at the wrong time			Vehicle Shut down and repair/replace device
		loss of power				
	Failure to transmit signal	Software failure	Vehicle waits too long at intersection	Intersection Sensors will detect car at intersection		Refresh/Reconnect
		Damaged transmitter or receiver	Vehicle goes through intersection at the wrong time			Vehicle Shut down and repair/replace device
		loss of power				
Intersection Sensors	Failure to detect vehicles	Damaged/disconnected sensors	Vehicles stalled at intersection	Lack of feedback	Bluetooth communication between vehicle and IC	Reconfigure/Replace Sensor
			System deadlock if intersection controller does not detect vehicle leaving	Check for correct signal when vehicle is at the intersection		
		Software failure	Vehicle collision			