Autonomous Vehicle Challenge 2017

Abstract

Learning Objectives:

- Group Work
- Project management
- Version Control tools
- CAD tools
- Writing professional engineering reports

1 Marks for the AVC

Overall the AVC is worth 25 % if your final grade for ENGR101.
This is broken into:

1. AVC Plan (2.5 %)
2. AVC Progress Report (2.5 %)
3. AVC Final Report (10 %)
4. AVC Robot (10 %)

2 Expectations

We expect you to spend at least 2 hours per week in the lab working on your robot. On top of this you will need to use your assignment time (also 2 hours per week) to document and report on your progress each week. We expect you to plan and work as a team, which means allocating tasks and holding responsible for completing those tasks. Documentation will be an important part of this.
We do not expect you to skip lectures, assignments or labs from any course in order to complete the AVC in time. In order to achieve this you will have to manage your time extremely effectively whilst juggling tests and assignments from other courses. Your team is only as strong as your weakest member. Rather than excluding less experienced team members, your team must aim to either teach them the necessary skills or at least give them other ways to contribute to the AVC.

3 Introduction

Welcome to the AVC for ENGR101 2017. Now go back and read the front page of this assignment, specifically the section on learning objectives. Notice anything missing? That's because your physical robot only contributes a fraction of your final grade for the AVC. This project's purpose is to teach you a range of other things, as well as how to build and test a small robot. For many of you your instinct will be to focus on the technical details of getting your robot to function correctly, however this will be insufficient to pass this assessment on its own. You will also be assessed on your ability to write, work as a team and plan keep records of your teams progress.

To this end you have several 'deadlines' for the AVC, one for a team plan, one for a draft report and one for the final report. Submission of the first two of these will gain you minimal marks, however the tutor feedback on what you submit will be crucial for gaining a high mark for the final report itself.

Due to the tight deadlines for marking and comments, late submissions for any of these deadlines will incur steep penalties, ranging from loss of marks to a lack of any written feedback to help you improve your final report to a maximum being set on the final grade your report may achieve.

3.1 AVC Steps

3.1.1 Step 1 - the First week

During your first week for the AVC your aim is both to get your robot moving using the default chassis provided to you and to produce a series of dated (weekly) milestones for your team to aim for to ensure completion of the group project in a timely manner. You will also decide on group roles and responsibility for the project. You will report on progess against these goals during your draft report submission down to a personal level. You will also be expected to create a group github repository for your project. Exemplars of all of these will be provided for you. It will be impossible for the group to complete all necessary tasks without delegating them.

3.1.2 Step 2 - First half of Challenge

During this period you will need to refine your robots software and hardware in order for it to progress through the challenge quadrants. You will also need to write the Background, Introduction and preliminary results and discussion sections of your final report during this time. At the very least the results and discussion sections should include a bullet-pointed summary of what you expect to include in them when further progress has been made. These will all need to be submitted at the progress report stage. During lab this week a mentor will meet with your group and discuss how all members are contributing to progress on the challenge. Progress on milestones set in the AVC plan will need to be supplied as part of this submission. During this period regular updates (at least weekly) should be made to the github project.

3.1.3 Step 3 - Second half of Challenge

During the final weeks you should focus on improving the performance of your robot through the challenge. As with the previous step, regular updated to the github project are expected, as are updates on the progress of team members against their assigned goals. When feedback on your report is available you should review it and begin making edits to the final version of your report. Ensure you decide when is appropriate to stop working on the robot and focus on your reports.

3.2 Step 4 - Writing the final report

The final report can be no more than 15 pages (excluding references). Reports longer than this will be read and marked to the 15th page only. The deadline is midday 13th June. No extensions will be given on this date expect for medical reasons which will require a doctor's certificate. Please ensure you have checked your report against the AVC report checklist prior to submission, as omission of any of these sections will result in a loss of marks for the final report.

4 AVC Rules

We will try to give taste of what engineering projects are in real life, within the safe confines of a University course:

You work in the team that is not of your own choice:
Your team members will be selected by us, and will consist of people within your own scheduled lab time.

You have a deadline, often perhaps even an non-reasonable one:
You have one attempt when called to the testing stand at Week 11. If your robot is not ready zero points are given for this test.

Your budget is limited:
Each group will be provided with a Raspberry Pi, a PCB (printed circuit board) including an H-bridge and a 10-bit ADC converter, motors and wheels (tracks if you so prefer). These pieces will form the bases of your vehicle. Each team will be also given $100 virtual dollars to spend at Parts Bazaar to purchase sensors for their vehicles. You dont need to spend all of your funds; however you must not go over the budget.

You should keep customers happy:
Please treat the judges as customers, i.e. please solve the tasks by engineering rather than finding loopholes in the rules. Consider whether your solution would make the customer happy!

5 Design Specifications

You should develop a robot to go through the testing range. There are also three additional requirements discussed later.

The testing range is 2x2 m square made out of 4 quadrants.

- Your robot should stay within the range and go from start to the finish position.
- Points are awarded based on how far your robot went through the range.
- Robot should be positioned at start line when testing commences
- You have 15 minutes of customer attention.
- Robot should be totally autonomous and no human intervention is allowed.
- You can take the robot back to the start line. 15 minutes timer keeps running.
- Robot should not change range as it moves through

A-quadrant: Your robot should follow a straight white line on black background, wirelessly open a gate and move through it.

B-quadrant: White line is arranged in curvy pattern, your robot must continue to follow it.

C-quadrant: White line is arranged in a maze pattern. You can consider some maze-solving algorithms.

D-quadrant: No white line. Maze made out of wall 100 mm high. Distance between walls 180 mm. No loops in the maze.

The group score will be out of 100.

- Completing quadrant 1 will be sufficient to get 40%.
- Completing quadrant 2 will be sufficient to get 60%.
- Completing quadrant 3 will be sufficient to get 80%.
- Completing quadrant 4 will be sufficient to get 100%.

We may give partial marks for some quadrants at our discretion, especially in quadrant 4.

5.1 Additional Requirements

The two additional requirements are: **Recyclability:** In recyclability we are looking specifically at how easy is it for us to get our parts back the sensors, micro controllers, motors etc. And as a hint, we like nuts, bolts and screws on our parts. Also making it recyclable makes it easier to repair or change if you discover a problem with your current design. Up to 10% can be taken off the group score for poor recyclability.

Aesthetics is all about how well it is designed from an engineer's point of view. Does it look like a mess of wires and parts or is it tidy, or colourful etc. The hard part will be making it recyclable and aesthetically pleasing because quite often those two things dont go hand in hand. Up to 10% can be taken off the group score if your robot looks like mess of wires.

6 Parts we give you

Each group will be provided with a Raspberry Pi, a PCB (printed circuit board) including an H-bridge and a 10-bit ADC converter, motors and wheels (tracks if you so prefer) and a wireless dongle. These pieces will form the base of your vehicle. You can use only one Raspberry Pi and no more than 2 motors for your robot.

Each team will be also given $100 virtual dollars to spend at Parts Bazaar to purchase sensors for their vehicles. You dont need to spend all of your funds; however you must not go over the budget. We have 5 different sensors available from the parts bazaar. They are:

- Short Range IR Sensor (digital)
- Medium Range IR sensor (analog)
- Lever action Whisker push buttons (digital)
- Limited number of 3D printed parts.
- 180° servos.

You can swap out sensors you no longer need to get other sensors or get the funds added back to your budget, but only at the parts bazaar you cannot swap parts with other groups. You can only use only parts we provide you or you made in-house (we don't want it to become a financial competition).

A part list and associated prices will be made available during the lab.

Additional items that you add to your vehicle, e.g. light dependent resistors, will be subtracted from the virtual dollars budget.

Teams may not trade parts with each other.

Batteries will be provided in each scheduled lab session AND MUST BE RETURNED AT THE END OF THE LAB. These are LiFe batteries, and need to be handled carefully so they are not damaged. If you wish to work on your vehicle outside of these times, you will need to sign out a battery from Arthur. This battery must be returned to Arthur.

7 In-house manufacturing

We will provide nuts, bolts and screws, hot glue guns and the glue for them, as well as ice block sticks, string/twine and a few other basic building materials.

We will also have a hand drill and soldering iron in the lab available for you all to use Arthur will take each lab session through a safety talk and safe use demonstration at the start of one of the labs sessions. We expect you to follow all safety instructions given to keep you and your fellow classmates safe.

You can use 3D printers to make your parts. Print time cannot exceed 40 minutes per individual part and teams cannot print more than 10 parts each over the course of the AVC. Parts that are to be printed are required in .stl format.

8 Vehicle Storage/Access

Each group will get a box to store their parts in and these will be stored in the shelves in CO145.

Any vehicle caught outside CO145 (and that has not being signed out), will cost that group a 5% penalty across their total score.

If there is scheduled lab then only students assigned to this lab can be in CO145. At any other time you can book seats CO145 for maximum of 2 hours. Maximum number of people in the lab is 36. You book by filling form at door of CO145.

9 Finals

The top six (or seven) robots that earned the most points will go to a Grand Challenge Finals Night during the final week of trimester. This is your second opportunity to improve the performance of your robot.

10 Report

Your robot will be assessed during your week 13 lab, and this assessment is worth 10% of your overall grade. This component will be done on a group-assessment basis, however you must be able to demonstrate that you contributed to the team to be eligible for any marks the team receives.

You will also have to write an individual (not team based) report on design of the robot. This is also worth 10% of your overall grade.

10.1 AVC Plan (2.5 %) - due Friday 5th May at midnight

Maximum Length: 2 pages Must Include:

- Dated milestones for AVC completion (at least weekly).
- Objectives for the next 3 weeks for each team member.
- A list of potentially conflicting assessment items and dates for each team member. (Including holidays, outside work commitments etc)
- Link to the team's github repository (which must also exist).
- A copy of the example team agreement (below) signed by each member.

10.1.1 Exemplar AVC plan

Team Name:
Team Members & contact info: Darren (darren@gmail.com), Bonnie (bonnie@myvuw.ac.nz), Tyler (tyler@myvuw.ac.nz), Leo (leo@myvuw.ac.nz)
Communication tool: (pick ONE: Email, Slack, Github, Facebook, google doc)
Roles:

- Darren: project lead and hardware support (organising team meetings, reporting regularly on progress, CAD designing components)
- Bonnie: software development (writing core code and extending functionality)
- Tyler: software testing and documentation (debugging software and committing to git, writing test cases and documenting performance against milestones)
- Leo: hardware (building the chassis, testing components, connecting sensors, debugging hardware)

An up to date version of our team's goals are available at `https://github.com/kaiwhata/Example_AVC_Repo` which includes all code, designs and a README.

Team Agreement

By signing below, all team members are acknowledging that they have read and committed to their part in the AVC. They acknowledge that they will attempt to complete the tasks agreed on by the group each week and document this on the team github account. They acknowledge that failure to meet these goals can result in the team recommending any member receives a lesser grade for their AVC report. In the event that a team member is unable to complete their task due to circumstances beyond their control (i.e. sickness, bereavement etc) that they will inform the team at the earliest possible time. Finally, the team acknowledges that a member going a week without contact with other team members (except when discussed with the team in advance) will constitute the member in question being considered AWOL. In this instance the team agrees to inform the ENGR101 course co-ordinator immediately. The penalty this for this can range from a reduction in the final grade to immediate failure of the AVC (and thus the ENGR101 course). Should the team unanimously agree that a member (or members) have failed to contribute to the AVC sufficiently for other reasons, on the day of robot testing the team will be given the opportunity to anonymously vote for a team member to receive 0% for the robot part of the AVC. Should the team choose this option they MUST be able to show that the member in question had been assigned tasks that they failed to complete and that the team had afforded them an opportunity to make up for past mistakes.

Signed by all team members: (Printed Name)/ (Signature)

AVC Task Plan

Table 1: Partially complete example AVC Plan Timetable

Week	Dates	Team Objective(s)	Items Due	Conflicting Commitments	Tasks
1	18th April	robot moving in straight line	AVC Plan due	PHYS122 test	[All] Complete AVC plan Bonnie: Arrange team meetings, check all have signed plan Darren: Produce code for straight line movement Tyler: Setup team github repository, implement sensor averaging Leo: Assemble chassis and hardware, develop prototype chassis
2	25th April	meet and plan for following week			[All] Write Background section Bonnie: Arrange team digital meeting, plan for following week Darren: Suggest order of method development Tyler: Update github with progress from last meeting Leo: Finalise chassis design
3	2nd May	quadrant 1 complete			[All] Write Methods section (robot description) Bonnie: check team member progress, plan for following week Darren: Develop robot movement code Tyler: Develop networking code, update github goals Leo: Characterise motors, chassis build commences
4	9th May	quadrant 2 complete		COMP102 test #2	[All] Write Results and Discussion Sections
5	16th May	quadrant 3 complete	Progress report due	ENGR121 test	[All] Update sections with new results
6	23rd May	quadrant 4 complete			[All] Update sections with new results
7	30th May		Robot Due	ENGR101 test #2	[All] Revise sections based on feedback
8	6th June				[All] Write Conclusion and Abstract sections
9	13th June		Final report due		

10.2 Weekly progress checklist for review

- How has each team member performed against their goal set last week?
- Have you set a goal for each team member for this week?
- Do any team members need more help to complete their assigned task(s)?
- Have you updated the task list on Github this week?
- Are all relevant code, bot photos and design files on the team Github?
- Have you noted which members attended labs and team meetings?
- Have team members shared their draft report sections (if the team decided they wanted to do that)?
- Are there any tasks that need to be done for progress tp be made that have NOT been assigned to a team member?

10.3 AVC Progress Report (2.5 %) - due midnight Monday 22nd May

Maximum Length: 15 pages

The purpose of the AVC progress report is to a) encourage you to work on your report before the final deadline and b) to give you practice writing and feedback on your report writing prior to submission of the final report. The feedback will include general comments about report structure and content. The markers will not proofread for you so it is your responsibility to spell and grammar check your work (or to get it checked for you) prior to submission. Whilst the progress report is not worth much (2.5% if your final ENGR101 grade) the quality and quantity of different sections can place limits on the maximum grade you can achieve for your final report.

As a minimum your progress report should follow the same structure as your final report (as in it should include the major sections: Introduction Background, Methods, Results and Discussion). As you will not have completed the full challenge before the report is due we suggest you focus your Results and Discussion on the performance of your robot in quadrants one and two and how you intend to improve its performance during the coming weeks prior to the completion of the challenge. Omission of any of the Introduction, Background, Methods or Results and Discussion sections in the progress report will result in your final report receiving a maximum of 75% of the possible marks for that section. On the positive side well written Introduction and Background sections for the progress report should require little (if any) changes for the final report. Similarly, well written Results and Methods sections will only require inclusion of new results before the final report.

ENGR101 Technical report writing guidelines are available here: `https://github.com/kaiwhata/ENGR101-2017/wiki/Report-Writing-guide`

10.4 AVC Final Report (10 %) - due midday Monday 19th June

Maximum Length: 15 pages (excluding appendices and references)

11 AVC submission checklist

- Do you have a title page?
- Have you included a link to your github repository? does that repository include all necessary code, diagrams and project documentation? Is it up to date?
- Have all members made at least 1 commit to the repository and has the repository been updated at least once per week?
- Have you included a completed version of your AVC plan?
- Have you incorporated the feedback you got on your plan and from the progress report?
- Does your report include references in the IEEE style?
- Is your report less than 15 pages?
- Does your report include all of the following sections:
  - Title Page
  - Abstract
  - Introduction
  - Background
  - Methods
  - Results
  - Discussion
  - Conclusions
  - References

12 AVC Report Writing Guide

Much more detailed guides on all sections are available on the ENGR101 Github Wiki here: `https://github.com/kaiwhata/ENGR101-2017/wiki`

12.1 Overview

Laboratory reports are a specific type of report, which engineers and computer scientists are often required to write. Although often analytic in content, information can be integrated into the report in order to demonstrate understanding and insight into the wider subject of the laboratory. Note that it is the work that is the subject of the report, e.g. to investigate the hardware of a personal computer, rather than the infrastructure around the work, e.g. do not write that the purpose of the lab was to pass Engineering 101!

The method by which the tests and evaluations are conducted through the apparatus and procedure must be included in the report, but only include important detail that allows the experiment to be replicated. Importantly, do not simply copy from the lab sheet.

Laboratory Report

Introduction	
• ***Purpose***	Describe the reason for writing this report.
• ***Problem***	Describe the context and hypothesis(es) for this report.
• ***Scope***	Describe the limitations of this report.
Background	
• ***Theory***	Review the theoretical basis of this research.
• ***Research***	Review prior research relevant to this research.
Test and Evaluation	
• ***Apparatus***	Describe device(s) used to do this research.
• ***Procedure***	Describe procedure(s) used to do this research.
Findings	
• ***Data***	Review the results of the test.
• ***Interpretation***	Provide your interpretation of the results.
Conclusion	
• ***Assessment***	State whether, and to what extent, the hypothesis is supported.
• ***Recommendations***	Provide your recommendation(s), if any.

The results present the findings, including the data and its interpretation. Discussion of any uncertainties, assumptions and debatable interpretation should be placed in a separate 'Discussion' section for formal reports.

Conclusions should state whether your initial hypothesis was supported. It should not state the mechanics of the laboratory, e.g. do not write 'we learned to put together a computer'. Recommendations are on the content of the laboratory, e.g. operating systems should be designed such that drivers cannot be installed prior to the kernel, rather than the laboratory itself, e.g. do not write 'laboratories should not start at 9 AM'.

Self reflection does not belong in the conclusion, e.g. do not write I realised that I had not previously known the difference between an ALU and a CPU. This can be placed in a blog or in an appendix. Appendixes are also useful if you have a lot of data and code, such that only the most important data/results belong in the main body of the work and the remainder supporting evidence in the appendix.