Proposal for the Approval of Researching on Autonomous Vehicles

Submitted To:

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Presented by: Dylan Leveille for CCDP 2100L

Team #: 1

Team Members: Dylan Leveille, Anil Menon and Anandarajah Yathuvaran

Team Topic: Autonomous vehicles are a safer means of transportation than human-controlled automobiles

Date Due:

October 9th, 2018

1.0 Introduction:

This proposal is a response to the call for proposals regarding the course instructor's approval to perform research on a cutting-edge technology. The purpose of this proposal is to obtain the approval to perform research on *autonomous vehicles*. Specifically, the aim of this research is to prove that autonomous vehicles could potentially be a safer alternative to human-controlled vehicles and could therefore prevent many road deaths from occurring. This proposal will present a background of the project's intention, a complete description of the project detailing each member's contribution, a project timeline, the team contract, the team's final thoughts, a glossary and a reference section. Lastly, terms which are defined in the glossary will appear in italics throughout the text.

2.0 Background:

On September 18th 2018, it had been decided by the instructor of the CCDP 2100 course for section L that teams would be created to perform research on a cutting-edge technology for a term project. The research performed by team 1 on autonomous vehicles could be beneficial to society since road deaths are an issue which could potentially be prevented by the deployment of autonomous vehicles.

In fact, according to the National Highway Traffic Safety Administration, in 2016, 37,461 people were killed in motor vehicle crashes in the U.S. [1]. This issue is also present in Canada where, in 2016, 1,171 people were killed in motor vehicle crashes [2]. As a matter of fact, U.S. safety regulators claim that 94% of all automotive accidents are caused by human error [3].

Considering the latter, autonomous vehicles could eliminate human errors from motor vehicle accidents and would allow, in two years, to save as many people as the number of Americans lost in the Vietnam war in the U.S. alone; a total of 58,220 lives [4], [5].

3.0 Project Description:

This project has been divided into three sub-sections, each of which containing two research questions. Each research question will also include a relevant engineering principle. The sub-sections, and the member assigned to each, is as follows:

3.1 Sensor Systems (by Anil Menon):

Research question #1:

- How do autonomous vehicles determine its distance from object?

Engineering principle for question #1: **Analog to Digital Converters**

- Description: Analog to digital converters are devices which convert a continuous *analog signal* into *digital signals* for computers to process [6].
- Role: The sensors found in autonomous vehicles, such as *proximity* and *depth* sensors, use analog to digital converters to convert the sensors' data from analog signals to digital signals [7].

Research question #2:

- What sensors are used in an autonomous vehicle?

Engineering principle for question #2: **The Hall Effect**

- Description: The Hall Effect creates a variable voltage output in response to the *magnetic field* produced [8]. These types of sensors are small and robust and are used to detect orientation precisely using magnetic fields [8].
- Role: This effect is used in several sensors in an autonomous vehicle to gather information about its surroundings [8].

3.2 Security (by Dylan Leveille):

Research question #1:

- How could autonomous vehicles be improved to be more secure?

Engineering principle for question #1: **LIDAR**

- Description: *LIDAR* is the technology which allow autonomous vehicles to classify objects around them and to create a digital world for them to respond to [9]. By doing this, LIDAR can also calculate an object's *behaviour* [10].
- Role: To improve safety in autonomous vehicles, LIDAR's range and resolution must be increased through software and hardware modifications or with the use of other technologies [10].

Research question 2:

- Could self-driving cars be victims of serious *cyberattacks*?

Engineering principle for question #2: **CAN (Controller Area Network) bus**

- Description: The *CAN bus* is the network inside every modern automobile which performs most of the intra-vehicular communications [11]. The CAN bus is comparable to the vehicle's central nervous system since it allows the vehicle's *status* to be modified [11].
- Role: Securing the CAN bus against cyberattacks is necessary to assure passenger safety in autonomous vehicles, since it is incapable of implementing basic security principles and can be accessed through an exterior connection, such as the internet [11], [12].

3.3 Automatic Emergency Braking (by Anandarajah Yathuvaran):

Research question #1:

- How does the Emergency Braking System work?

Engineering principle for question #1: **Emergency Brake Actuator**

- Description: According to Davies [13], actuators are hardware that perform physical actions such as braking when instructed to by the car's computer. They can be compared to the muscles in the human body responding to signals sent from the brain [14].
- Role: Brake actuators are a crucial component in the emergency braking system, as they control the braking of the vehicle depending on the data received by the sensors [15].

Research question 2:

- How can the mechanism of the braking system be improved?

Engineering principle for question #2: **Dynamics**

- Description: According to Painting [16], when *torque* is exerted on an object, its rotational speed will alter. The *friction* exerted by the break pads on the wheels of a vehicle produces torque on the main *axle*, which slows it down and brings the vehicle to a stop [16].
- Role: To improve the mechanism of the braking system, the dynamics involved, such as torque, friction, and *pressure*, can be enhanced with improved brake components [17].

4.0 Project Timeline:

The project timeline is given in Appendix I.

5.0 Team Contract:

The team contract is given in Appendix II.

6.0 Conclusion:

If this proposal is approved, the research performed by team 1 could demonstrate that autonomous vehicles are safer than human-controlled vehicles. This research could then potentially lead to the deployment of autonomous vehicles to prevent road deaths; an issue that, if solved, could allow many lives to be saved. The team leader is willing to provide answers to any questions about this proposal and can be contacted at any time by email at the following address: dylanleveille@cmail.carleton.ca. Team 1 is looking forward to the approval of this proposal.

Sincerely,

Dylan Leveille

Glossary

Analog signal: A continuous sine wave that may differ in amplitude and time [18]. These signals have no breaks [18].

Autonomous vehicle: For this proposal, an autonomous vehicle refers to any type of car, including trucks, that is fully autonomous but where the driver's responsibility to scan the environment still exists [19].

Axle: A shaft or pin on where a pair of wheels revolve [20].

Behaviour: In the presented context, a behaviour, refers to an object's speed and direction [10].

CAN bus: This digital network receives short messages, such as RPM, from the vehicle's nodes (ECU's) and distributes these messages to all of the other nodes to provide data consistency within the system [21].

Cyberattacks: Cyberattacks are malicious attempts to access or damage a computer system which, in the case of autonomous vehicles, can lead to endangering one's life [22].

***Depth sensor*:** A sensor that can detect the quality of deepness using RGB or infrared imaging [23].

Digital signals: A continuous sine wave that may differ in amplitude and time. These signals have no breaks [18].

Friction: A force which resists the motion between two solid objects in contact [24].

LIDAR: LIDAR (short for Light Detection And Ranging) is the bulky equipment mounted on the roofs of autonomous vehicles which constantly spins and fires beams of lasers to digitize the environment around it [10].

Magnetic field: Created when current such as electrons flows threw a conductor producing geometric shapes of magnetic flux vectors [25].

Pressure: The perpendicular applied force on an object per unit area [26].

***Proximity sensor*:** Directing electromagnetic beams to detect an object near the vicinity without actually having any physical contact [27].

Status: Refers to the vehicle's attributes, such as the vehicle's speed, the engine's RPM, the gear selection, the gas pedal position and more [11].

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Appendix

Appendix I

Project Timeline – Team 1

Table 1 below is a timeline of our team's due dates, meetings and deadlines.

Table 1: Project Timeline for Team 1

Date	Itinerary
September 21st, 2018	**Due:** ➢ Engineering principle #2 and research question #2. ➢ Meet the peer mentor for approval.
September 23rd, 2018	**Meeting #1:** ➢ Meeting minutes taken by Anil Menon ➢ Practice presentation of the Project Outline.
September 25th, 2018	**Due:** ➢ Class presentation of the Project Outline. ➢ Project Outline soft-copy and presentation slides due on CU Learn forum. ➢ Provide all team members with a handout and provide the judges with a handout and presentation slides. ➢ Research entry #1 for log book.
October 2nd, 2018	**Due:** ➢ Draft #1 of Project Proposal. ➢ Project Outline peer mentor approval form due end of class.
October 4th, 2018	➢ Get peer mentor or Elsie Mcgill to review Project Proposal.

October 9th, 2018	**Due:** ➢ Project Proposal final copy (soft-copy) due on CU Learn before class. ➢ Proposal Assignment folder (includes hard-copy of Project Proposal and preliminary drafts) ➢ Research entry #2 for log book. ➢ Research exchange session #1.
October 10th, 2018	➢ Prepare to write first draft of preliminary report
October 14th, 2018	**Meeting #2:** ➢ Meeting minutes taken by Anandarajah Yathuvaran. ➢ Practice presentation of Preliminary Findings.
October 16th, 2018	**Due:** ➢ Research exchange session report #1. ➢ Presentation of preliminary Findings. ➢ Write first draft of Preliminary Report.
October 17th, 2018	➢ Work on preparing to write final version of Preliminary Report.
October 30st, 2018	**Due:** ➢ Preliminary Report final version which will be written in class. ➢ Presentation of Preliminary findings self-assessment folder. ➢ Research entry #3 for log book.
November 6th, 2018	**Due:** ➢ Research exchange session #2.
November 7th, 2018	➢ Prepare to write final report draft #1

November 13th, 2018	**Due:** ➢ 1st draft of Report of Findings. ➢ Research entry #4 for log books. ➢ Soft-copy of project log book due on CU Learn. ➢ Prepare for Presentation of Findings.
November 16th, 2018	➢ Get peer mentor or Elsie Mcgill to review Report of Findings draft #2.
November 18th, 2018	**Meeting #3:** ➢ Meeting minutes taken by Dylan Leveille. ➢ Practice Presentation of Findings.
November 20th, 2018	**Due:** ➢ Team leader emails Instructor the presentation slides. ➢ Presentation of Findings.
November 27th, 2018	**Due:** ➢ Presentation of Findings self-assessment folder. ➢ Individual components of Report of Findings (both hard-copy and soft-copy) ➢ Prepare first draft of Letter of Transmittal.
December 4th, 2018	**Due:** ➢ Contribution to Team and Class section of CU Learn (hand in all soft-copies). ➢ Team and Individual component of Report of Findings (both hard-copy and soft-copy). ➢ Individual Letter of Transmittal final version.
December 5th, 2018	**Due:** ➢ Team Letter of Transmittal (email letter and team report to Instructor).

Appendix II

Team Contract – Team 1

Team 1:

Dylan Leveille, Anil Menon and Anandarajah Yathuvaran.

Team goals:

- To learn better communication skills, both orally and written.
- To learn about autonomous vehicles and acquire enough knowledge to promote them as an alternative to human-controlled automobiles.
- To get an A+ in the course since simply passing the course isn't satisfying for neither one of us.

Team Leader role:

- The team leader will post a reminder of upcoming deadlines the day they are announced in class on the Facebook group (see "How Will We Communicate" for details about the Facebook group). A deadline reminder will also be posted weekly (every Friday) and 48 hours before the assignment is due.
- The team leader will evenly assign tasks to each member depending on what parts of the project should be completed. If any member disagrees with a given task, they may propose to do an alternative task to the team leader.

Participation and Behaviours:

- Team members **will** be continuously participating to the project by posting an update on the work they have completed during the week on every Friday.
- Members should review each other's work before it is submitted or compiled into the final document.
- Although no member should feel forced to provide support to other members, this behaviour is **strongly** recommended to boost team morale.

Attendance expectations:

- Unless a member cannot attend a meeting due to a serious reason (e.g., being ill), members must be present for every meeting.

Roles and Responsibilities:

- Dylan Leveille will be team leader.
- Every member should plan in advance to assure they have enough time to complete their assigned tasks and deliver a quality product. Deliverables are expected to be posted by each member on the Facebook group 24 hours (at the latest) before the due date identified in the project timeline.
- If a member needs help with their part of the project, they should post their question on the team's Facebook group. Following this, other members are encouraged to provide resources for this person.

How Will We Communicate:

- The main way members will communicate is through the Facebook group created for the project.
- Communication by email is also acceptable, although less practical for group conversations.
- Members can also schedule a group meeting to discuss something they believe requires the presence of every member.

Backup communication:

- Members will have the phone numbers of every other member in the event of a project component requiring immediate attention.

How will decisions be made:

- A consensus will be made for every project decision through the Facebook group or in person.
- No conclusion will be made until every member has agreed to proceed with the decision.

Use of log books/discussion groups for meeting agendas and minutes:

- A different team member should be taking meeting minutes for every meeting that is expected to last for more than an hour. These minutes should be posted within one week of the end of the meeting.

- No member should post their questions on the team forum; the forum is used exclusively to hold research notes, minutes and deliverables (if required). Questions to other team members should be asked on the Facebook group or by email.
- Each logbook (research notes) that is required by the course outline must be submitted to CuLearn on before the due date.

Guidelines for sharing research resources, and research notes:

- Posted research notes must follow have the following order (in descending order):
  - The title of the research notes.
  - The title for subtopic #1.
  - The research question titles for subtopic #1.
  - The title for subtopic #2.
  - The research question titles for subtopic #2.
  - The references section (in IEEE format).
- The notes for each research question must be inserted under the appropriate title for that question.
- The formatting style of the notes must adhere to the *CCDP 2100 - Style Guide* document found on the course's CuLearn page.
- Every member has the right to ask another member (through the Facebook group) to see their progression on their part of the project. A member should not attempt to hide their work from others; the received criticism may result in improving the quality of their work and is therefore beneficial.

- All relevant information found by a member should be posted in the research notes. No member should remove information from their notes they believe is unimportant as it may be useful to other members.

Problem solving approaches/ensuring equal opportunities for team participation:

- If a problem (task) must be solved in the project, the team leader will first propose a solution through the Facebook group. Every member is welcome to add suggestions to the solution to help create the best overall course of action.
- If the team leader cannot forge a solution to the problem, a mandatory meeting will be arranged to discuss the problem and brainstorm solutions.
- Tasks will always be separated in equal ratios. If a member feels they have too much work to do (or not enough), they may communicate with the team leader to discuss alternatives.
- Members have the permission to challenge the ideas and the solutions offered by other members which they believe are incorrect as long as it is done respectably.

Conflict resolution:

- If there emerges a conflict between team members, a team meeting will be arranged to decide on a mutual agreement which doesn't halt the completion of the project. Following this, if no agreement has been made, then another team meeting will be conducted with the instructor.

Consequences:

- A team member who is late at a meeting (under 10 minutes) will not suffer any consequences. After this time frame, the late member will be questioned to explain his late arrival. Being late for a meeting will only be tolerated once, after which a meeting will be made with the team members and the instructor. A member who fails to attend the meeting will receive an email from the team leader requiring him to explain his absence. If this email has not been replied to within the following class (or has been replied with a poor explanation of his absence), the member will to asked to meet with the instructor and the team to discuss his attendance.
- A member who fails to respond to a question posted on the Facebook group which could considerably affect the project's timeline will be met during the next class period to discuss his lack of communication. If the reason was of serious nature (e.g., he felt a serious deterioration of health) then no consequences will be made. If this isn't the case, and it is the first time the member ignored his messages, then the member will receive a warning against such behaviour. If this member ignores messages for a second time, a team meeting will be made with the instructor at the end of the following class to discuss his bad habits.
- A team member who delivers a poor-quality product will be communicated with (by an email from the team leader) to have him explain the reasoning behind his result. If the team leader feels the member could redeem himself on his part of the project, he will be given 24 hours to significantly improve the work he has made. If the member fails to accomplish this, he will be forced to attend a team meeting with the instructor. If the member delivers

a flawed assignment for a second time, he will not be granted 24 hours to improve his work and must instead attend a team meeting with the instructor.

- The final consequence of not meeting the team expectations is being *fired*.

Name:	**Signature:**
Dylan Leveille	_____
Anil Menon	_____
Anandarajah Yathuvaran	_____