ECE496 Project Proposal (Draft B)

Tour Guide Robot

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Team 140

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1. Executive Summary

Most modern museums share a common problem: they lack effective methods to attract and maintain visitors. This document is aimed to present sufficient context for this problem through background research, as well as providing a sound solution bridging the gap between the problem and the museum's existing solution. Our team of four engineers aim to design and build a working tour guide robot that guides visitors around in a museum and present an attractive alternative to present information and attract tourists.

The document also lists the robot’s functional requirements, objectives, and constraints in order for the team to define its boundaries and evaluate its success. Moreover, validation and acceptance tests table are also provided, to help the team validate the robot’s final design.

The document then utilizes a Work Breakdown Structure (WBS) to represent the major tasks the team must divide and accomplish in order to complete the design project. This is done using a Gantt chart in a hierarchical format to better manage individual tasks. A budget table is also provided in the financial plan to document the cost of the project.

Finally, this document gives an honest assessment to the feasibility of the entire proposal, listing skills and resources required for the project. This section also describes the major risks involved in the design process and the potential mitigation strategy towards them.

2. Table of Contents

3. Project Description

3.1 Background and motivation

Museums play an important role in our society when it comes to education and entertainment [2]. However, the number of museum visitors in North America has been in a downward trend since 1982 [1]. Among all age groups, children and teenagers (below the age of 24) had the sharpest decline: -17% from 2012 to 2017 [1]. In fact, a survey was done as early as 2004 shows the elderly (above the age of 55) are becoming the largest population group (at 36%) among all museum visitors in Canada [3]. One of the causes of this phenomenon is the incompatibility of the youth's energetic nature and the slow relaxing environment of a typical museum: more and more young people find non-interactive recreations like going to a museum unattractive.

A study done in 2006 found [4], although most modern museum are equipped with audio guides either as a traditional headphone set or a phone app, typical museum visitors are still not inclined to read signs nor listen to information about exhibits. Not only that, most museum kept audio length for each exhibit under 2 minutes in order to compensate for an average person's attention span, and yet up to 70% of all exhibits in a museum still only receive cursory glances [4]. Is there a way we can maximize the delivery of information to the visitors in an interesting and digestible way?

One solution to this problem is to improve the way people enjoy museum visits. We can fully utilize human's nature curiosity towards animate objects such as robots [5] to maximize the delivery of information. Instead of walking around aimlessly from one exhibit to another, a tour guide can be provided by the museum, creating an overarching narrative for the visitor. And instead of the typical voice-over in your digital audio guide, our autonomous robot can lead visitors around, telling the unique stories about each exhib along the way. Compared to the traditional audio guides, our solution excels at attracting the attention of the youth and create companionship for the elderly, and ultimately boosts museum's ability to attract visitors.

3.2 Project goal

The goal of this project is to design and build a working model of a personal guidance robot that is capable of self-navigation, object avoidance as well as providing voice-over interactions for each exhibit. The design also has to meet the “Standards for community museums in Ontario [6]” to which it would provide service.

3.3 Project requirements

ID	Project Requirement	Description
1.0	Movement	**Primary functional requirement:** Able to get from point A to point B
2.0	Input: 5V for powering the controller	**Subfunction:** The controller must be able to work with a low voltage battery (9V)
3.0	Multispeech functionality	**Subfunction:** Robot must be able to support multiple languages and ‘speak’ in one of the supported languages selected by user.
4.0	Size: 50cm x 50cm x 150cm (length x width x height)	**Constraint:** The robot must not exceed this size to be able to path through doorways. This excludes additional components added to make the robot interactive e.g. outer shells.
5.0	Minimize weight	**Objective:** the lower the better. Weight will be traded off against other characteristics.
6.0	Receive Input	**Requirement:** Robot must be able to receive input from sensors to detect its surroundings
7.0	Decision Making	**Requirement:** Control software must be able to make decisions based on the inputs received.
8.0	Have basic obstacle avoidance	**Requirement:** Must be able to stop if an obstacle is detected and start when the obstacle is no longer in its path

9.0	Multidimensional Movement	**Requirement:** Robot must be able to move in x and y direction - forward, backward, left and right
10.0	Control of peripherals	**Requirement:** Control system must be able to control the peripherals like motors
11.0	Audio output	**Requirement:** Robot must be able to output audio containing information about the exhibs
12.0	Navigation	**Requirement:** Robot must be able to follow a predetermined path

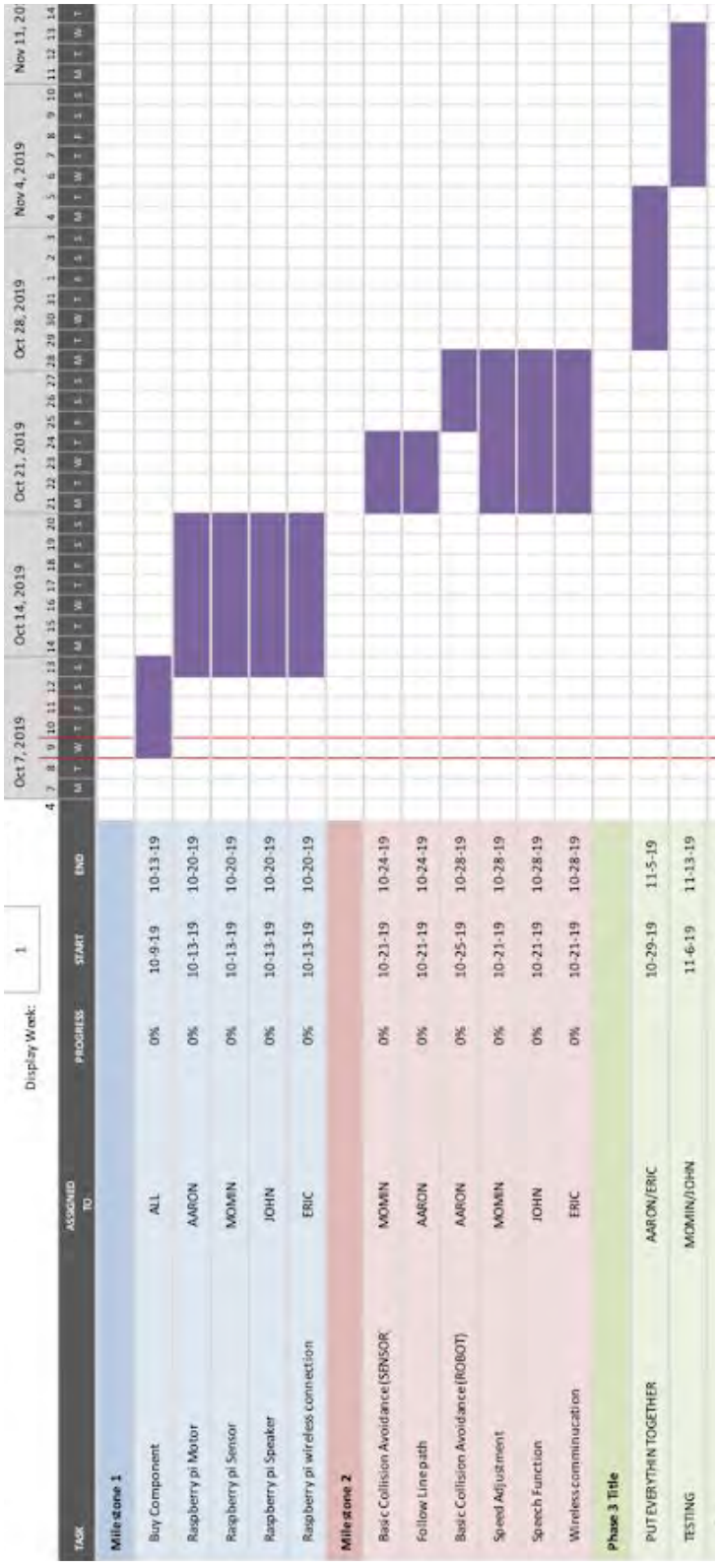
3.4 Validation and acceptance tests

ID	**Project Requirement**	**Verification Method**
1.0	Movement	**Test:** Check if it can go from one point to another successfully
2.0	Input: 5V for powering the controller	**Test: test power supply against our circuit board (raspberry pie)**
3.0	Multispeech functionality	**Test:** Choose a language and verify whether the robot can speak in it
4.0	Size: 50cm x 50cm x 150cm (length x width x height)	**Test:** Direct measurement
6.0	Receive Input from surroundings	**Test:** Test we get correct input from the sensors
7.0	Decision Making	**Test:** Test that the robot can decide when it is time to move onto the next display
8.0	Have basic obstacle avoidance	**Test:** Test the robot does not run into an object placed in its path
9.0	Multidimensional Movement	**Test:** Direct measurement
10.0	Control of peripherals	**Test:** Check the robot can send and receive signals from its peripherals

11.0	Audio output	**Test:** Test the robot can output audio when needed
12.0	Navigation	**Test:** Verify it can go from point A to point B in a predetermined path

4. Work Plan

4.1 Work breakdown structure and Gantt chart



Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Milestone 1				
Buy Component	ALL	0%	10-9-19	10-13-19
Raspberry pi Motor	AARON	0%	10-13-19	10-20-19
Raspberry pi Sensor	MOMIN	0%	10-13-19	10-20-19
Raspberry pi Speaker	JOHN	0%	10-13-19	10-20-19
Raspberry pi wireless connection	ERIC	0%	10-13-19	10-20-19
Milestone 2				
Basic Collision Avoidance (SENSOR)	MOMIN	0%	10-21-19	10-24-19
Follow Line path	AARON	0%	10-21-19	10-24-19
Basic Collision Avoidance (ROBOT)	AARON	0%	10-25-19	10-28-19
Speed Adjustment	MOMIN	0%	10-21-19	10-28-19
Speech Function	JOHN	0%	10-21-19	10-28-19
Wireless comminucation	ERIC	0%	10-21-19	10-28-19
Phase 3 Title				
PUT EVERYTHIN TOGETHER	AARON/ERIC		10-29-19	11-5-19
TESTING	MOMIN/JOHN		11-6-19	11-13-19

4.2 Financial plan

	Value ($)
Funding	
Student ($100)	400
Total	**400**

	Priority	Cost per Unit ($)	Quantity	Total Cost ($)	Requires Funding
Consumable & Services					
Work Venue	1	0	1	0	n
Computer Access for Group	1	0	1	0	n
Software Package Subscription	2	60	1	60	n
Total				**60**	
Capital Equipment					
Microcontroller	1	81	1	81	n
Camera	2	23	1	23	n
UltraSonic Sensor	1	3	1	3	n
Motors and Chassis	1	18	1	18	n
Sound Recorder	1	75	1	75	n
Speaker	1	10	1	10	n
Total				**210**	

[7], [8], [9]

Total Funds Available (without grant): $400

Total Required Funding: $270

As total funds available are greater than total required funding, it does not look like we will require grant funding. Our contingency funds are $130. Currently, forecasted expenses amount to 67.5% of available funds.

4.3 Feasibility Assessment

4.3.1 Skills and Resources:

1. Basic knowledge of programming in both software (C, C++, python) and hardware (Lego Mindstorm, Raspberry).
2. A workspace where we can build and test hardware components.
3. Ability to work efficiently together as a team. This should include proper delegation of work, timely completion of work and good communication within the team.

4.3.2 Equipment:.

1. A gaming laptop with a GTX1660Ti GPU or above.

4.3.3 Risks and Mitigation Strategy

One essential aspect of this project is the interaction with the user. Fundamentally, this requires good sound input and output. Unfortunately, high quality sound devices are often very expensive, ranging into the 100’s or even 1000’s of dollars. We have tried to make the best choices for sound production and recording for our robot on a budget. Unfortunately, it is very difficult to gauge the quality of sound devices online, and it might be the case that the quality of the devices we are currently looking into might not be sufficient.

We have come up with three solutions to try and minimise this risk. The first is to wait on buying the sound equipment, using a laptop sound recorder and speaker in the meantime to develop the voice interactions with users. Having already worked on this problem through a laptop, it will give us a better understanding of the requirements of the needed sound equipment when buying.

The second solution is to avoid buying a device online, and instead buying it physically in a shop. This may be more expensive, but will give us a better idea of the quality of the device we are buying.

The final solution is in the case that we purchase a device that we later find to be insufficient for the problem. We hope that this situation does not occur, but if it does, we might fall back on the sound recording and production capabilities of one of our mobile phones. Current mobile phones have very good sound recording and production capabilities, which could be used for our robot. One downside to this method would be the compatibility issues we would have in connecting a mobile phone with the microcontroller.

5. References

[1] “Art Museum Attendance,” Humanities Indicators - A project of the American academy of arts & science, Aug-2019. [Online]. Available: https://www.humanitiesindicators.org/content/indicatordoc.aspx?i=102. [Accessed: 18-Sep-2019].

[2] E. N. Arinze, “The Role of the Museum in Society - Public lecture at the National Museum, Georgetown, Guyana” 17-May-1999. [Online]. Available: http://www.maltwood.uvic.ca/cam/activities/past_conferences/1999conf/batch1/CAM'99-EmmanuelArinze.GuyanaFinal.pdf. [Accessed: 18-Sep-2019].

[3] Heritage Information Network, “Survey of Visitors to Museums,” Canada.ca, 30-Apr-2019. [Online]. Available: https://www.canada.ca/en/heritage-information-network/services/web-interactive-mobile-technologies/survey-visitors-museums-web/results.html. [Accessed: 18-Sep-2019].

[4] Levi T. Novey, Troy E. Hall, Science Learning in Everyday Life, “The Effect of Audio Tours on Learning and Social Interaction: An Evaluation at Carlsbad Caverns National Park” Wiley InterScience, 24-July-2006 [Online]. Available: http://illinois-online.org/krassa/hdes598/Readings/Technology/Effect%20of%20audio%20tours%20on%20learning.pdf [Accessed: 26-Sep-2019].

[5] J. Pratt, P. V. Radulescu, R. M. Guo, and R. A. Abrams, “It’s Alive! Animate Motion Captures Visual Attention,” Association For Psychological Science, 2010. [Online]. Available: It’s Alive! Animate Motion Captures Visual Attention. [Online]. Available: http://abrams.wustl.edu/artsci/reprints/PrattRadulescuGuoAbrams2010.pdf [Accessed: 09-Oct-2019].

[6] Government of Ontario, “Standards for community museums in Ontario,” Ontario Ministry of Tourism, Culture and Sport, 28-Feb-2017. [Online]. Available: http://www.mtc.gov.on.ca/en/museums/museums_standards.shtml. [Accessed: 18-Sep-2019].

[7] “Adeept Mars Rover PiCar-B WiFi Smart Robot Car Kit for Raspberry Pi 3 Model B /B/2B, Speech Recognition, OpenCV Target Tracking, Video Transmission, STEM Educational Robot with PDF Instructions, Robotics Kits - Amazon Canada,” Adeept Mars Rover PiCar-B WiFi Smart Robot Car Kit for Raspberry Pi 3 Model B /B/2B, Speech Recognition, OpenCV Target Tracking, Video Transmission, STEM Educational Robot with PDF Instructions, Robotics Kits - Amazon Canada. [Online]. Available: https://www.amazon.ca/Adeept-Recognition-Transmission-Educational-Instructions/dp/B07KM3YCYP/ref=pd_rhf_se_p_img_3?_encoding=UTF8&psc=1&refRID=85QQPTF98JPZWTX88XQ4. [Accessed: 07-Oct-2019].

[8] “Sony ICDPX370 IC Voice Recorder, black: Amazon.ca” Sony ICDPX370 IC Voice Recorder, black: Amazon.ca. [Online]. Available: https://www.amazon.ca/Sony-ICDPX370-IC-Voice-Recorder/dp/B06XFTWCBJ/ref=sr_1_2?keywords=sound+recorder+for+laptop&qid=1570716441&s=toys&sr=1-2-catcorr. [Accessed: 07-Oct-2019].

[9] “Speaker - PCB Mount,” Robotshop.com [Online]. Available: https://www.robotshop.com/ca/en/speaker-pcb-mount.html. [Accessed: 07-Oct-2019].

6. Appendix

6.1 Appendix A: Student-supervisor agreement form
(see attachment)

6.2 Appendix B: Draft A feedback form (from ECP)
(see attachment)

ECE496 Design Project

Student – Supervisor Agreement

Our signatures below indicate that we have read and understood the following agreement, and that all parties will do their best to live up to the word as well as the spirit of it.

We agree to meet at least once every two weeks for at least half an hour to discuss progress, plans, and problems that have arisen. Before each meeting, the group will prepare a brief progress report that will form the basis for the discussions at the meeting.

If a meeting has to be cancelled by the supervisor, she/he should advise the group as early as possible. If a student cannot attend a meeting, she/he should advise members of the group as well as the supervisor as early as possible.

Both the supervisor and the students will:

- Inform themselves of the course expectations and grading procedure.

The supervisor will:

- Provide regular guidance, mentoring, and support for his/her design project group(s),
- Take an active role in evaluating the work and performance of the students' by completing the supervisor's portion of the grading forms for each course deliverable expediently.
- Return a photocopy of the completed grading evaluation forms to the appropriate section administrator in a timely fashion.
- Be aware of the aims and processes of the course as outlined in the Supervisor's Almanac.

We have read and understood this agreement. Date: Oct 7, 2019

Signature of supervisor: _____

Signature of student: John Courtney

Signature of student: Morris Helmwood

Signature of student: Boyce Lin

Signature of student: Zihan Zhao

Last revision: 7/08

496 Draft A Feedback Form

l in your project title, session code, and meeting details, and staple this form to the front of your Draft A Proposal.

et Title:	TOUR GUIDE ROBOT	
sion Code:	D24200	Meeting Date, Time, and Place: Tuesday 24th Sept MY661

ground and Motivation	Introduces the design problem and its context including state of the art and existing work and technology. Identifies a motivation for the project and the proposed solution.	Comments: Background explained. Require research on existing interactive exhibition designs.
ct Goal	Summarizes what the project aims to achieve. Focuses on the desired result and not the implementation. Identifies main criteria by which the success of the project can be evaluated.	Comments: ~~The~~ FOBs for the robot (physical & functional are explained, how about the information part ↓
ect Requirements	Defines the scope of the project. Functions and constraints are verifiable and objectives are measurable. Requirements are solution-independent and support the project goal.	Comments:
ssible Solutions & Alternatives	Describes possible alternatives and discusses design trade-offs.	Comments:
asibility Assessment	Identifies skills, knowledge, and resources required to complete the project. Acknowledges credible risks the project could face and a mitigation strategy for these risks.	Comments: missing
eferences	Includes reputable engineering sources. References are complete, cited and support claims made in the document.	Comments:
Writing Quality	Uses clear, concise, and correct language; tone is appropriate for audience and purpose; document is carefully proofread.	Comments:

Specific Areas for Improvement:

- Define the gap based on the existing solutions.
  Clearly differentiate bet. the existing solution and your design.
  Justify the need for a personal ~~guidance~~ guidance system.

- project goal
  define FOCs for the voice over part of the design.

- significance of the "introduction" sets hot so you ~~don't~~ go further into the document.